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A Preliminary Survey of the Fresh-water Algae of Eastern Kansas

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ABSTRACT: This paper reports 241 species for Kansas. Of this number 202 species are new records for the state and include the descriptions of the following five new forms.

Euglena truncata Walton var. *baculifera* var. nov.
Euglena alata sp. nov.
Phacus inflata sp. nov.
Merismopedia angularis sp. nov.
Cosmarium sexpapillosum sp. nov.

Lepocinclis truncata Da Cunha described from Brazil and *Lepocinclis turbiniformis* Deflandre, described from Venezuela, are reported from the United States for the first time.

INTRODUCTION

PREVIOUS publications on the fresh-water algae of the state of Kansas have been those of Prof. F. W. Cragin (Bull. Washb. Coll. Lab. (1:1, 1884), (1:2, 1885), (1:6, 1886), (2:9, 1889), B. B. Smyth (Trans. Kansas Acad. Sci. 13:1892), G. H. Curtis (ibid. 17: 1899-1900), J. B. McNaught (ibid. 29:1920), L. L. Bailey (ibid. 35: 1932), and S. A. Mannoni (ibid. 35:1932). Collectively, these publications give a list of 141 species of algae for the state. This list contains representatives in 5 classes, 5 orders, 8 families and 46 genera.

The algae being reported in the present paper represent 9 classes, 19 orders, 44 families and 116 genera. The four new classes are Rhodophyceae, Dinophyceae, Cryptophyceae and Charophyta. The total number of species and varieties is 241. The following is a

table illustrating the taxonomic distribution of the algae in the present paper.

Class	Orders	Families	Genera	Species
Myxophyceae	3	7	21	39
Rhodophyceae	1	1	1	1
Heterokontae	2	2	2	2
Chrysophyceae	2	3	4	4
Cryptophyceae	1	1	1	1
Chlorophyceae	9	28	79	146
Dinophyceae	..	..	1	2
Euglenophyceae	..	1	5	44
Charophyta	1	1	2	2
	19	44	116	241

From this table it is easily seen that the Myxophyceae, Chlorophyceae and Euglenophyceae comprise the bulk of the determined species and that the majority are in the Chlorophyceae. Aside from the fact that the class Chlorophyceae contains the largest number of species of fresh-water algae of all the classes, its overshadowing of the other classes in number of species cited in most taxonomic papers is perhaps also due to three other facts; first, that a large number of the Chlorophyceae are nonmotile; second, that they either form macroscopic thalli or aggregate in such amounts as to be very prominent; and third, that they themselves are either large or of a striking morphological distinction.

Although the algae reported in this paper were collected for the most part within Douglas county, they afford a good representation of the possible algal flora of the state as a whole. This is true since they are, with few exceptions, the most common forms met with in any locality and have in many cases been repeatedly collected from several different stations. The few collections the author was able to make in the southern and central portions of the state yielded some new species. They were for the most part desmids and other algae of acid waters. This was to be expected, since the collections were made in sandstone and sand-hill regions. An intensive and extensive study of the waters in those regions would undoubtedly yield more new forms and they would probably be largely desmids and other algae of acid waters.

In these collections were also found many species that had already been found in the vicinity of Lawrence. Notable among them, in the unicellular forms, were species of Trachelomonas, Euglena, Phacus, Lepocinclis and Tetraëdron; in the filamentous forms of green algae, species of Spirogyra, Zygnema, Cladophora, Pithophora, Stigeoclonium, Hormidium and Chaetophora; in the unicellular and filamentous blue-greens, species of Chroococcus, Gleocapsa, Oscil-

latoria and Phormidium. These organisms seem to be tolerant to a change of waters from slightly acid to quite alkaline, from an approximate acidity of pH 6.5 to 7.5.

The algae described in this paper have been collected from intermittent pools, swamps, small ponds, lakes, streams, moist soil, and moist rocks, the majority being from still or slowly running waters. The southern collections were made from the Verdigris river and a small lake at Neodesha, Chetopa creek at Altoona, Neosho river, Santa Fe pond, Village creek and an adjacent swamp at Chanute, and Deer creek at Garnett. Collections were also made from the temporary waters of ditches and small pools in each of these places. The collections from central Kansas were made from a small lake and intermittent pools in the sand hills near Burrton. At Lawrence the majority of the collections were made from the boat slough at the north end of Ohio street and the adjacent swamp by the Kaw river. Other stations from which frequent collections have been made are at the Kaw river dam, the drainage ditch south of Haskell Institute, a pond on the property of R. R. Jackman about one mile west of the University campus, and an intermittent pool in the abandoned quarry on east Fifteenth street. Collections were also made from the Wakarusa river, the country club spring, the city park pool, and many temporary waters in ditches along outlying roads.

There have been quite a number of species of algae in culture which have not been identified, either because there has not been sufficient material, or the necessary stages in reproduction have not been evident for complete determination. For example, there have been a number of obviously different species of Spirogyra and Mougeotia in culture, but there have been no fruiting bodies. Since accurate, specific determination of the members of these two genera is entirely dependent on the dimensions and characters of the zygotes, or in the case of Mougeotia the aplanospores also, they have been undetermined. Some of the species of Spirogyra that have been reported for the state (Mannoni, 1932) have been determined entirely on the dimensions of the vegetative cells and the number of chloroplasts within a cell. Neither of these is a good criterion to species without the zygote, since cell measurements vary with the age of the cell in width as well as in length and the number of chloroplasts may vary among the cells of the same filament. Mougeotia is difficult to determine since fruiting material is very rare and determination is absolutely dependent on the characters of the zygote or aplanospore.

Four new species and one new variety are being described in this paper: *Euglena truncata* Walton var. *baculifera* var. nov., *Euglena alata* sp. nov., *Phacus inflata* sp. nov., *Merismopedia angularis* sp. nov., *Cosmarium sexpapillosum* sp. nov. Also, two species of Lepocinclis are being reported for the United States for the first time: *Lepocinclis truncata* Da Cunha and *Lepocinclis turbiniformis* Deflandre. *L. truncata* was described and reported from Brazil only, and *L. turbiniformis* was described and reported from Venezuela only. Of the 241 species reported on in this paper, 39 have been previously reported for the state. The remaining 202 species are entirely new for the state.

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DESCRIPTION OF SPECIES

CLASS MYXOPHYCEAE

ORDER CHROOCOCCALES

FAMILY CHROOCOCCACEAE

Chroococcus limneticus Lemm.

(Pl. 1, fig. 3)

Cells paired, 4-32 in a colonial gelatinous mass. Individuals 8-16 mu in diameter with the capsule, without the capsule 6-12 mu in diameter; pale olive to light blue-green. The capsule is either distinct or obscured by confluence in the colonial mass. Planktonic in temporary or permanent waters.

Coll. Sept., 1935, swamp in Chanute, 1935, 1936, 1937, Jackman's pond, drainage ditch in Haskell bottoms, Lawrence.

Chroococcus turgidus (Kütz.) Näg.

(Pl. I, fig. 1)

Cells generally single or 2-4, rarely as many or more than eight in a group. Cell body blue-green or yellowish to brownish. Cells 13-40 mu in diameter with the capsule, 8-32 mu without the capsule. Capsule colorless, generally distinctly layered. Common, but never found in quantity, on mud bottoms of still waters, but most frequently found among the filaments of green algae.

Coll. Sept., Oct., 1935, Jackman's pond, Potter's pond, Haskell bottoms, boat slough at north end of Ohio street, old quarry on East Fifteenth street, Lawrence.

Chroococcus dispersus (v. Keiss) Lemm.

Cells in colonies of from 4-16 or more within a gelatinous envelope, the cells either closely packed or widely dispersed throughout the mass, pale to bright blue-green. Diameter with the capsule 5-6 mu, without the capsule 3-4 mu. The capsule is distinct, not layered and not confluent with the colonial envelope, colorless. Planktonic in habit.

Coll. Sept. to Nov., 1935, and in the spring of 1936, Jackman's pond, City park pool, East Fifteenth street quarry, Lawrence.

Chroococcus caldariorum Hansg.

(Pl. I, fig. 2)

Aggregate cells forming a slimy mass, on wet soil, that is liver-red in color, or bright blue-green when the red pigment is absent. This layer may cover large areas. Cells purple-red to violet, 5-15 mu in diameter with the capsule, 3-6 mu in diameter without the capsule. Capsule more or less thick, not layered and colorless. Common on moist soil and walls in greenhouses.

Coll. Jan. to May, 1935, 1936, 1937, Botany greenhouse, Kansas University, Lawrence.

Gleocapsa mellea Kütz.

(Pl. I, fig. 5)

Aggregate cells form a crust on moist walls and moist earth which is pale-flesh-colored to yellowish. Individual cells are 2.5-5.5 mu in diameter, spherical to angular, in globose to irregular colonies of two to many cells. Capsule hyaline and colorless; cell body flesh-colored to golden-yellow.

Coll. Dec., 1936, Chanute, on moist soil.

Gleocapsa magma (Bréb.) Kütz.

(Pl. I, fig. 4)

Aggregate cells form a crumbly layer on moist cliffs which is copper-red to purple-brown. Cells 6-12 mu in diameter with the capsule, without the capsule 4.5-7 mu in diameter. Capsule layered, copper-red or colorless. Cell body light blue-green.

Coll. Dec., 1936, on moist cliffs where water was seeping out, Chanute.

Gleocapsa aeruginosa (Carm.) Kütz.

(Pl. I, fig. 6)

Aggregate cells form a crust, crumbly or slimy, blue-green to gray-green. Cells with the sheath 4-8.8 mu, without the sheath 2-3 mu in diameter, blue-green. Few to many in a colony. Sheath colorless, rather thick, either not at all or only slightly layered.

Coll. Dec., 1936, on a limestone cliff, Chanute.

Merismopedia punctata Meyen

(Pl. I, fig. 8)

Colonies small, cells loosely aggregated, 2.5-3.5 mu in diameter, pale blue-green. In standing water.

Coll. spring, 1936, Green's pond, Lawrence.

Merismopedia elegans A. Br.

(Pl. I, fig. 9)

Colonies small or large, 16-4000 cells. Cells more or less close, 5-7 mu wide, 5-9 long, light blue-green.

Coll. Oct., 1935, Jackman's pond, Lawrence.

Merismopedia elegans A. Br. ?

(Pl. I, fig. 10)

Colonies small, cells large and closely aggregated, 10-15 mu wide, 7-15 mu long. This species is being tentatively determined as *M. elegans* since its dimensions overlap into those of *M. elegans* and even though the dimensions are greater for the most part, the cell shapes are the same as those of *M. elegans*.

Coll. Sept., 1937, Jackman's pond, Lawrence.

Merismopedia angularis sp. nov.

(Pl. I, fig. 14)

Coloniae sunt satis grandes, crasso glutinoso involucro intectae. Cellulae sunt 4.4 mu latae, 6.5 mu longae, 4-6 mu altae, pentagoniae, uno polo plano, altero acuto. Cellulae in duplicibus ordinibus positae sunt. Plani poli cellularum utriusque ordinis oppositi sunt planis polis alterius ordinis. Acuti poli apti sunt inter acutos polos proximi ordinis. Color corpori cellulae est clare caeruleus. Involucrum coloniae est pellucidum.

Colonies moderately large with a thick gelatinous envelope Cells 4.4 mu wide, 6.5 mu long, 4-6 mu thick arranged in a flat plate with two rows of paired cells alternating with two more rows of paired cells. Color of cell body, a bright blue-green. Colonial envelope colorless.

Coll. July, 1937, Chanute.

Eucapsis alpina Clem. and Schantz

(Pl. I, fig. 11)

Colony a cube of cells surrounded by a thick envelope. Cells a bright blue-green, 7 mu long, 7.6 mu wide.

Coll. spring of 1937, Green's pond, Lawrence.

Aphanothece microscopica Näg.

(Pl. I, fig. 12)

Colonial mass free-floating in standing water, small, ellipsoidal to amorphic, ¼-2 mm. in size. Cells ellipsoidal to cylindric, single or in pairs, 4-4.5 mu wide, 1½-2 times as long, bright blue-green Among filaments of green algae in still water.

Coll. Jan., 1936, City park pool, Jackman's pond, Lawrence.

Microcystis marginata (Menegh.) Kütz.

(Pl. I, fig. 7)

Colonies spherical or irregular, not composed of smaller division colonies massed together. Cells spherical, 3.6 mu in diameter.

Coll. April, 1937, Green's pond, Lawrence.

ORDER CHAMAESIPHONALES

FAMILY PLEUROCAPSACEAE

Pleurocapsa minor Hansg. em. Geitler

(Pl. I, fig. 13)

Colonial mass consisting of a basal portion and an erect portion. The basal portion forms a rhizoidal, branched system over the substrate. The erect portion, also filamentous, is either uniseriate or multiseriate. Cells 3-9 mu in diameter, pale blue-green.

Coll. Jan., 1935, Olathe, on *Basicladia chelonum.*

FAMILY CHAMAESIPHONACEAE

Chamaesiphon cylindricus Boye

(Pl. I. fig. 15)

Sporangium cylindrical, without a definite foot, 2-2.5 mu wide, 11-13.2 mu long, extension of the sheath thinner above than at the base. Endospores few, generally 1-2. Epiphytic on filamentous green algae.

Coll. April, 1935, on Oedogonium and Rhizoclonium, boat slough at north end of Ohio street, Lawrence.

Chamaesiphon gracilis Rhabh.

(Pl. I, fig. 17)

Sporangium slightly stalked, gradually attenuated to a point from the base, outward, solitary or gregarious on the filaments of green algae. Sporangium 1.5-2 mu wide, 25-30 mu long.

Coll. Oct., 1935, on Cladophora, Jackman's pond, Lawrence.

ORDER HORMOGONALES

SUBORDER HOMOCYSTINEAE

FAMILY OSCILLATORIACEAE

Spirulina major Kütz.

(Pl I, fig. 20)

Trichomes 1-2 mu wide, non-septate, pale blue-green, winding 2.5-4 mu wide, distance or lead of the turn 2.7-5 mu. In still water.

Coll. Oct., 1935, Jackman's pond, Lawrence

Arthrospira jenneri (Kütz.) Stiz.

(Pl. I, fig. 23)

Trichomes blue-green, not at all or slightly constricted at the cross walls, 5-8 mu wide, the ends not attenuated Winding 9-15 mu wide, lead 21-31 mu. Cells short or almost square, and cell broadly rounded. In standing water.

Coll. Nov., 1935, June, 1937, Green's pond, Lawrence.

Oscillatoria gleophila Grün.

Trichomes 3.7-4.5 mu wide; cells as long as broad, cross wall more or less constricted and more or less granulated. In the gelatinous material of *Chaetophora elegans*.

Coll. March, 1936, East Fifteenth street quarry pool, Lawrence.

Oscillatoria curviceps Ag.

(Pl. I, fig. 16)

Trichomes light or dark blue-green, slightly attenuated and curved at the ends, not constricted at the cross walls, 10-17 mu wide. Cells one third to one sixth times as long as broad, 2-5 mu long, cross wall much granulated. End-cell not button-shaped, flat-rounded or truncate.

Coll. Dec., 1935, Jackman's pond, Lawrence.

Oscillatoria simplicissima Gom.

(Pl. I, fig. 19)

Trichomes dark blue-green to yellowish blue-green, not constricted at the cross walls, not attenuated at the ends, 8-9 mu wide. Cells one fourth to one half as long as wide, 2-4 mu long, not granulated at the cross walls. End-cell not button-shaped, half-round with or without a perceptible thickening of the wall.

Coll. Jan., 1936, Potter's pond, University of Kansas campus, Lawrence.

Oscillatoria jenensis G. Schmid.

(Pl. I, fig. 22)

Aggregate mass of trichomes dark brown. Trichomes 19.8-24.9. mu wide, not constricted at the cross walls, gray-brown, somewhat spiraled at the ends. Cells short, end-cell asymmetric-convex, not knobbed or thickened. No granulation at the cross walls.

Coll. Botany department greenhouse, 1935, Potter's pond, University of Kansas campus, Lawrence.

Oscillatoria sancta Kütz.

(Pl. I, fig. 18)

Trichomes straight or bent, not distinctly constricted at the cross walls, lightly attenuated at the ends, 10-20 mu wide, dark blue-green to dirty olive-green. Cells one third to one sixth as long as broad, 2.5-6 mu long, not granulated at the cross walls. End-cell half-round and flattened, lightly knob-like with a thicker cell wall on the end.

Coll. Sept., 1935, Potter's pond, University of Kansas campus, Lawrence.

Oscillatoria guttulata van Goor.

(Pl. I, fig. 21)

Trichomes bent, not constricted at the cross walls, two to four and one half, mostly 3-4 mu wide, end-cell neither tapered nor knobbed. Cells almost quadratic or up to twice as long as broad, 3½-8 mostly 6 mu long. End-cell broadly rounded, cross walls very obscure or indistinct. Cells very pale blue-green with pseudovacuoles. There are fine granules present at the cross walls

though not regularly enough to permit measurement of the cell length. The cross walls are most easily demonstrated by mounting the material in a hanging drop over iodine crystals and allowing the drop to dry. The cover slip is then mounted on a slide in water, the cross walls becoming quite evident as the iodine diffuses out, though they do not show up while the material is at first in the hanging drop.

Coll. March, 1937, drainage ditch in Haskell bottoms, Lawrence.

Phormidium tenue (Menegh.) Gom.

(Pl. I, fig. 24)

Trichomes straight or lightly curved, very slightly constricted at the cross walls, attenuated at the ends, 1-2 mu wide, light, pale blue-green. Cells up to three times as long as broad, 2.5-5 mu long, not granulated at the cross walls.

Coll. 1935, 1936, 1937, boat slough at north end of Ohio street, Jackman's pond, Potter's pond, common in cultures from vicinity of Lawrence.

Lyngbya Birgei Smith

(Pl. I, fig. 25)

Trichomes straight, seldom curved, 20-24 mu wide. Sheath colorless, homogenous, 0.5-4 mu thick. Trichomes not constricted at the cross walls; end-cell rounded but not attenuated. Cells shorter than broad, 2.5-5.5 mu long, 18-23 mu wide, many times with pseudovacuoles.

Coll. Dec., 1935, Potter's pond, Lawrence.

Lyngbya aerugineo-coerulea (Kütz.) Gom.

(Pl. I, fig. 27)

Filaments curved, sheath thin, colorless, not layered, the aggregate mass of filaments dark blue-green. Cells 4-6 mu wide, 1-1½ times as long, not constricted at the cross walls, but sometimes granulated, pale blue-green. End-cell truncated or rounded with a slightly thickened membrane.

Coll. Nov., 1935, boat slough at north end of Ohio street, Lawrence.

Microcoleus vaginatus (Vauch.) Gom.

(Pl. I, fig. 26)

Filaments single, creeping or joined into a greenish-black layer, wound and much branched. Sheath colorless, thick. Cells 3.5-7 mu wide, 3-7 mu long, often granulated at the cross walls and not constricted, bright blue-green. End-cell knob-like.

Coll. 1937, Botany department greenhouse on moist soil, Lawrence.

SUBORDER HETEROCYSTINEAE

FAMILY NOSTOCACEAE

Anabaena californica Borge.

(Pl. II, fig. 4)

Trichomes straight and parallel with a hyaline sheath. Cells cylindrical, slightly constricted at the cross walls, 5-5.5 mu wide, 5-6 mu long. Heterocysts 6.5-7.5 mu wide, 10.5-12 mu long. Resting cells at some distance from

the heterocysts, one or two in a row, cylindrical, straight, rounded at the ends, 6.5 mu wide, 14.5-17 mu long with a smooth outer sheath.

Coll. March, 1937, swamp, Chanute.

Nostoc muscorum Kütz.

(Pl. II, fig. 5)

Colony at first globular, later irregularly expanded over the substrate, lobed by splitting and curled at the edges. Cells short-cylindric or orbicular, 3-4 mu wide, as long as broad. Resting cells oval, 4-8 mu wide, 8-12 mu long, with a smooth yellow sheath. On moist earth and rocks and in greenhouses.

Coll. April, 1936, moist soil near Santa Fe pond, Chanute.

Nostoc fuscescens Fritsch var. *mixta* Fritsch

(Pl. II, fig. 2)

Colonies globular with a short stipe which attaches them to the substrate. Colonial sheath yellow-brown. Trichomes curled and constricted at the cross walls. Cells 3-4 mu wide, pale blue-green. Heterocysts oval to ellipsoidal, 5-7 mu wide, 6-7 mu long. Resting cells not known.

Coll. Dec., 1936, moist limestone cliff, Chanute.

Nostoc verrucosum Vauch.

(Pl. II, fig. 1)

Colony at first spherical to ovoid, later becoming loosely flattened out over the substrate. Colonial sheath thick and tough. The filaments at the periphery of the colony thickly interwoven. Cells short-barrel-shaped, 3-3.5 mu wide. Resting cells oval, 5 mu wide, 7 mu long with a smooth yellowish outer layer. Generally there is a fairly obvious radial arrangement of the filaments from the center.

Coll. March, 1937, Jackman's pond, Lawrence.

Nostoc coeruleum Lyngb.

(Pl. II, fig. 3)

Colonies spherical, free-living in standing water, with a thick, tough, smooth sheath that is slightly if at all pale blue-green. Trichomes very thickly massed. Cells short, keg-like in shape, 5-7 mu wide. Heterocysts broad-oval, up to 10 mu wide. Resting cells unknown.

Coll. March, 1937, swamp in Chanute.

Cylindrospermum maius Kütz.

(Pl. II, fig. 6)

Layer dark olive-green. Cells cylindric or almost quadratic, 3-5 mu wide, 3-6 mu long, pale blue-green. Trichomes constricted at the cross walls. Heterocysts long, somewhat broader than the vegetative cells, up to 10 mu long. Resting cells single, ellipsoidal, 10-15.4 mu broad, 20-38 mu long, with a brown papillose outer layer.

Coll. Oct., 1935, Botany department greenhouse, Lawrence.

Cylindrospermum minutissimum Collins

(Pl. II, fig. 7)

Layer blue-green. Cells cylindrical, 2-2.7 mu wide, 4-7 mu long. Heterocysts somewhat long, 4 mu wide, 6-8 mu long. Resting cells one or two in a row, somewhat longish, 7-9 mu wide, 12-25 mu long, with a smooth, colorless outer sheath.

Coll. April, 1936, Jackman's pond, Lawrence.

FAMILY SCYTONEMATACEAE

Scytonema myochrous (Dillw.) Ag.

(Pl. II, fig. 12)

Filaments joined in a dark-brown to dark-green layer on moist earth or stones. Filaments 18-36 mu wide, 2-15 mm. long. False branching common, either one or two branches coming from the same point on the main filament. Cells 6-12 mu wide, quadratic or up to two times as long as broad, disc-shaped on the ends of the trichomes. Heterocysts ovoid or rounded-quadratic.

Coll. Dec., 1936, on moist limestone cliffs, Chanute.

Plectonema Golenkiniana Gom.

(Pl. II, fig. 11)

Filaments free, not forming a layer, intermingling with filamentous green algae. False branching common with a single pseudobranch coming from a point of origin on the main filament. Trichomes long, slender and surrounded by a tough sheath that is colorless. Heterocysts are never present. Trichomes 1.2-1.8 mu wide.

Coll. Common in cultures from stagnant waters, 1935-1937.

FAMILY RIVULARIACEAE

Calothrix Braunii Born. and Flah.

(Pl. II, fig. 9)

Filaments straight, parallel, 9-10 mu wide, at the base weakly bulb-shaped. Sheath colorless. Cells 6-7 mu wide, constricted at the cross walls, somewhat shorter than broad. Heterocysts basal, hemispherical to half-ovoid.

Coll. Oct., 1935, Potter's pond, Jackman's pond, Lawrence.

Rivularia compacta Collins

(Pl. II, fig. 10)

Trichomes with individual sheaths, sheaths confluent in the hemispherical colony. Colony not lime encrusted. Trichomes with a basal heterocyst and attenuated from the heterocyst outward.

Came up in culture, 1935, Lawrence.

Rivularia planctonica Elenk.

(Pl. II, fig. 8)

Colony small, 0.5 mm. in diameter. Trichomes straight or curved, up to 300 mu long, 4.5-5.8 mu wide. Sheath narrow, colorless, scarcely visible. Cells almost quadratic or somewhat longer than broad, with pseudovacuoles. Heterocysts 8-9.8 mu long, single.

Came up in culture, 1935, Lawrence.

CLASS RHODOPHYCEAE

SUBCLASS PROTOFLORIDAE

ORDER BANGIALES

Porphyridium cruentum Näg.

(Pl. II, fig. 13)

Cells spherical, growing in a layer on damp soil, the layer appearing blood-red. Resting cells contain a dark-red, stellate chloroplast with a central pyrenoid.

Coll. Dec., 1935, 1936, damp soil, Chanute; 1936, damp soil in Botany department greenhouse, Lawrence.

CLASS HETEROKONTAE

ORDER HETEROTRICHALES

FAMILY TRIBONEMATACEAE

Tribonema bombycinum (Ag.) Derbes and Sol.

(Pl. II, fig. 19)

Filaments consist of cells that are cylindrical or barrel-shaped, 2-5 times as long as broad. Cells 5-20 mu wide (mostly between 7 and 13 mu). Cell walls composed of H-shaped pieces which come apart readily. Chloroplasts numerous and discoid. Reserve foods stored as oils or granules of leucosin.

Coll. 1936, on pots in the Botany department greenhouse, Lawrence.

ORDER HETEROSIPHONALES

FAMILY BOTRIDIACEAE

Botrydium granulatum Wallroth

(Pl. II, fig. 14)

Cells unicellular, multinucleate and terrestrial. The thallus consists of a vesicular portion and a rhizoidal portion. The vesicular portion may be either globose or dichotomously forked (if growing in a very shaded place). The vesicular portion may be from 1-2 mm. in diameter, has a relatively tough wall within which is a parietal sheet of cytoplasm with embedded chloroplasts. The material collected formed both hypnospores and aplanospores, the whole mass assuming the shape of the original vesicle and having a frosty appearance in contrast to the shining yellow-green of the vesicle.

Coll. 1936, damp soil, Botany department greenhouse, Lawrence.

CLASS CHRYSOPHYCEAE

ORDER CHRYSOMONADALES

SUBORDER CHROMULININEAE

FAMILY CHROMULINACEAE

Chromulina ovalis Klebs

(Pl. II, fig. 17)

Cells solitary, free-swimming, naked, ovoid to spherical, pyriform or spindle-shaped, with two parietal, plate-like chloroplasts, one on either side of the protoplasts. Cells 6-7 mu wide, 9-14 mu long, flagellum half again longer than the body.

Coll. March, 1937, boat slough at north end of Ohio street, Lawrence. It occurred in such quantity as to form a yellow-brown scum on the surface of the water.

FAMILY MALLOMONADACEAE

Mallomonas tonsurata E. Teil.

(Pl. II, fig. 16)

Cells solitary, uniflagellate, with a firm ornamented periplast covered with minute siliceous scales, from some of which arise long siliceous spines, ellipsoidal, the posterior end rounded, the anterior end pointed. A single large yellow chloroplast is parietal in position and appears as two from the side. At the posterior pole are two contractile vacuoles. Cells 18 mu long, 7-8 mu wide. The material collected was 15.2 mu long, 8.4. mu wide.

Coll. March, April, 1937, boat slough at north end of Ohio street, Lawrence.

SUBORDER ISOCHRYSIDINEAE

FAMILY SYNURACEAE

Synura uvella Ehrenb.

(Pl. II, fig. 15)

Cells radially united in spherical to oblong-ovoid colonies that are not enclosed by a gelatinous sheath. The cells are pyriform with the anterior end broadly rounded and the posterior end prolonged into a hyaline stalk. The firm periplast is covered with siliceous scales that are arranged spirally and the anterior end may be ornamented with short siliceous spines. There are two laminate, curved chloroplasts arranged within the cell so that their concave faces are opposed. There are two flagella of equal length at the anterior end. Colonies 100-400 mu long. Cells 20-40 mu long, 8 to 17 mu wide.

Coll. March, April, 1937, boat slough at north end of Ohio street, Lawrence.

ORDER CHRYSOTRICHALES

FAMILY PHAEOTHAMNIACEAE

Phaeothamnion Borzianum Pascher?

(Pl. II, fig. 20)

In February and March, 1937, the palmella stage of a species of Phaeothamnion was collected growing on submerged stems in water coming from a spring. The cells were loosely arranged in gelatinous tubes either in a single row or in two rows in the tube with the cells alternating in position. Single cells measured 7.6 mu in diameter and contained one to four parietal chloroplasts which were more greenish-yellow than golden-brown. Although accurate determination of Phaeothamnion species is not possible from the palmella stage alone, this material may be tentatively determined as of the species *P. borzianum.*

CLASS CRYPTOPHYCEAE

ORDER CRYPTOMONADALES

FAMILY CRYPTOMONADACEAE

Cryptomonas ovata Ehrenb.

(Pl. II, fig. 18)

Cells solitary, free-swimming with two flagella of equal length. Cell body long-ovoid, a little broader at the anterior end and obliquely truncate, often weakly bent. A conspicuous gullet extends from the oblique anterior surface almost two thirds of the length of the body. There are two large parietal chloroplasts and may be numerous leucosin grains. Cells are either slightly or greatly compressed, 20-80 mu long, 6-20 mu wide and 5-18 mu thick. The material collected measured 16.5-19.8 mu wide, 39.6-46.2 mu long.

Coll. July, 1937, small temporary swamp and pool near Chetopa creek, Altoona.

CLASS CHLOROPHYCEAE

ORDER VOLVOCALES

FAMILY CHLAMYDOMONADACEAE

Chlamydomonas intermedia Chodat

(Pl. III, fig. 1)

Cells elliptical with a thin but clear membrane. The chloroplast is massive and cup-shaped with one pyrenoid lying near the center of the cell. An eyespot is present near the anterior end. Cells biflagellate, 18-20 mu long.

Coll. March, 1936, Jackman's pond, Lawrence.

Chlamydomonas variabilis Dang.

(Pl. III, fig. 6)

Cells broadly ellipsoidal to almost cylindrical with a very evident papilla at the anterior end from which arise the two flagella. Flagella 1½ times the body length, 18-23 mu, width 12-15 mu. Eyespot at the side just above the equator and protruding.

Coll. July, 1937, Village creek swamp, Chanute.

Chlorogonium spirale Scherf. and Pasch.

(Pl. III, fig. 3)

Cells very narrow-spindle-shaped with a single, parietal, spiraled chloroplast. The eyespot varies in position from the anterior end to the middle at the side. One pyrenoid is present. Cells 20-40 mu long, generally only 3-5 mu wide.

Coll. July, 1937, Burrton. In a stock pool in the sand hills.

Chlorogonium euchlorum Ehrenb.

(Pl. III, fig. 2)

Cells broadly spindle-shaped, the anterior pole drawn out into a snout frequently, 25-70 mu long, 4-15 mu wide; the material collected measured 20-30 mu long, 8-13.2 mu wide. The chloroplast is diffuse and almost entirely fills the cell. Pyrenoids are few to numerous, generally more than two, though individuals with one and two and none at all were seen. Stages in asexual reproduction and the formation of gametes were also seen in culture, though no fusion of the gametes was seen.

Coll. Came up in an old culture from Santa Fe pond, Chanute.

Carteria cordiformis (Carter) Dill

(Pl. III, fig. 5)

Cells very slightly compressed, oval-shaped in the narrow view, broadly rounded in the wide view with a slight depression at the anterior end in which the four flagella are inserted. The chloroplast is cup-shaped and may not have a pyrenoid. An eyespot is evident, anterior in position.

Coll. March, 1937, Green's pond, Lawrence.

FAMILY PHACOTACEAE

Phacotus lenticularis (Ehrenb.) Stein

(Pl. III, fig. 7)

Solitary, free-swimming, biflagellate cells in which the protoplast lies within an envelope composed of two overlapping halves. The outer portion of the two halves is either smooth or sculptured and may be yellow-brown to very dark colored and impregnated with calcium carbonate. The halves have a slight flange on their opposed rims, are shallow so that they give a biconvex shape to the cell in side and top view and a subcircular shape from the front. Sexual reproduction has never been observed. In vegetative division the gelatinous material between the protoplast and the halves increases in quantity, pushing the halves apart, and the protoplast divides to form four or eight zoöspores which may escape or remain within the old mother cell to form a palmelloid stage. Cells 11.4-15.2 mu long, 7.6 mu wide.

Coll. March, 1937, swamp, Chanute.

Wislouchiella planctonica Skvortzow

(Pl. III, fig. 4)

Cells strongly compressed; protoplast surrounded by a wall which has a broad wing-like expansion and upon which are borne blunt cylindrical processes. Front and side views show that there are two processes on each compressed face: one process inserted at the cell's apex and projecting upward, the other projecting downward from its insertion at the base of the protoplast. In

vertical view these processes are seen to be axial and opposite in position, but the upper pair lies at an angle to the plane of the lower pair. The protoplast is ovoid to pyriform in front view and rhomboidal in vertical view. Two long flagella are diagonally inserted. The chloroplast is massive and cup-shaped; the eyespot lies some distance back from the anterior end. In the material collected the cells measured 16.5-19.8 mu wide, 19-19.8 mu long; the protoplast measured 13.2 mu wide, 13.2 mu thick and 16.5 mu long.

Coll. July, 1937, stock pond in the sand hills, Burrton.

FAMILY VOLVOCACEAE

Gonium sociale (Duj.) Warming

(Pl. III, fig. 8)

Colony four-celled, arranged in the same plane with a matrical connection between the individuals. Cells 10-22 mu long, 6-16 mu wide.

Coll. March, 1935, field ditch near Blue Mound, Douglas county, Lawrence.

In another collection, Green's pond, Lawrence, 1937, March, *Gonium sociale* was found, in which the individuals were very loosely held together with a seeming protoplasmic connection between the posterior poles. (Pl. III, fig. 8b.)

Gonium formosum Pasch.

(Pl. III, fig. 9)

Colony sixteen-celled, cells farther apart than in *G. pectorale* with larger spaces in between the connecting strands and no large matrix around the border of the colony. Cells almost pyriform, with the base broadly rounded to almost flat, 10.7 mu wide, 13.2 mu long. Chloroplast large, cup-shaped and containing a single pyrenoid.

Coll. July, 1937, Village creek, Chanute.

Pandorina morum (Müller) Bory

(Pl. III, fig. 10)

Colonies 4, 8, 16, or 32-celled, in the vegetative colony the cells closely packed, in a reproducing colony cells wide apart, the colony Eudorina-like. Cells pyriform or oblate-spherical, 9-17 mu long or wide. Reproducing colony, Pl. XIX, fig. 1.

Coll. June, 1937, drainage ditch in Haskell bottoms, Lawrence.

Eudorina elegans Ehrenb.

(Pl. III, fig. 11)

Colonies spherical to obovoid, 16, 32, or 64-celled. Cells fairly wide apart, 16-24 mu long. Flagella two to four times the cell diameter; chloroplast cup-shaped and containing several pyrenoids; eyespot quite evident near the anterior pole of the cell.

Coll. April, 1935, boat slough at north end of Ohio street, Lawrence.

Volvox perglobator Powers

Colony 1,000-1,500 mu in diameter with many thousand of equal-sized cells. Dioecious, over a hundred egg cells occur in the posterior portion of the female

colony, 50-100 antheridial cells in the male colony. Zygotes stellate with short blunt warts on the outer wall.

Coll. June, 1937, temporary pond and swamp near Chetopa creek, Altoona.

FAMILY SPONDYLOMORACEAE

Spondylomorum quaternarium Stein

(Pl. IV, fig. 1)

The colony consists of eight or sixteen loosely associated cells in alternating tiers of four each and no colonial matrix. The anterior end of the cells is broadly rounded and has a minute papilla on which are borne four flagella. The posterior end is abruptly and definitely pointed. The protoplast is nearly filled with a large chloroplast that may or may not contain a pyrenoid. The eyespot is posterior in position. The colony is up to 50 mu long; cells 10-26 mu long, 8-15 mu wide.

Coll. March, 1935, came up in an infusion of hay and barnyard dirt, Lawrence; July, 1937, temporary pond near Chetopa creek, Altoona.

FAMILY SPHAERELLACEAE

Sphaerella lacustris (Girod.) Wittr.

(Pl. IV, fig. 2)

The motile cells are ovoid to ellipsoidal, biflagellate and solitary. The protoplast is somewhat pyriform and lies some distance in from the wall to which it is connected by thin cytoplasmic strands. The flagella lie in gelatinous canals which fork from the anterior pole of the protoplast. The chloroplast contains several pyrenoids and may be obscured by the presence of haematochrome which also obscures the eyespot that lies at the equator of the cell. Zoöspores up to 51 mu wide, up to 63 mu long; microgametes up to 8 mu wide, up to 10 mu long; aplanospores 30-50 mu in diameter.

Coll. spring, 1936, Botany department greenhouse pool, Lawrence; Feb., 1937, a rain barrel, Chanute.

ORDER TETRASPORALES

FAMILY TETRASPORACEAE

Tetraspora cylindrica (Wahelnb.) Ag.

(Pl. IV, fig. 5)

Colony up to a meter long, 2-15 mm. thick. Cells in groups of four and 2-17 mu in length.

Coll. Feb., 1935, Olathe, in a small swift-running stream; March, 1937, Village creek, Chanute.

Tetraspora gelatinosa (Vauch.) Desv.

(Pl. IV, fig. 3)

Colony at first attached, later free-floating, up to 20 cm. thick, irregular in shape, often held erect in standing water by the elaborated gas which collects as a large bubble in the top of the sac. Cells 2-14 mu in diameter.

Coll. Feb., 1935, 1936, 1937, swamp near the boat slough at north end of Ohio street, quarry pool on East Fifteenth street, Lawrence.

FAMILY COCCOMYXACEAE

Ourococcus bicaudatus Grob.

(Pl. IV, fig. 4)

Cells very variable in form from egg-shaped to spindle-shaped, with either both ends sharply drawn out into a point or one end rounded and the other pointed and either slightly curved or greatly bent. Cells 4-9 mu wide, 2-4 times as long. Chloroplast parietal with one pyrenoid.

Coll. July, 1937, temporary pond in the sand hills, Burrton.

Coccomyxa dispar Schmidle

(Pl. IV, fig. 6)

Cells cylindrical and irregularly placed throughout a colonial matrix which is made up of the confluent sheaths of the individuals. The chloroplast is a longitudinal, parietal plate which does not encircle the cell and which lacks a pyrenoid. Cells 2.5-4 mu wide, 6.5-10 mu long. Those collected measured 2.5 mu wide and 5.8 mu long.

Coll. March, 1936, East Fifteenth street quarry pool, Lawrence.

Nannochloris bacillaris Naumann

(Pl. IV, fig. 7)

Cells solitary and without a gelatinous envelope; subspherical to subcylindrical in shape. There is one discoid chloroplast without a pyrenoid at one end of the cell. Cells less than 4.5 mu long, those collected measured 3.8 mu long, 3 mu wide.

Coll. Jan., 1936, Jackman's pond, Lawrence.

Chlorosarcina consociata (Klebs) G. M. Smith

(Pl. IV, fig. 8)

Cells in flat packets of four to twenty with a distinct envelope around the plant mass. Chloroplasts parietal with a single pyrenoid. Cells 18-25 mu wide. Those collected were 19.6 mu in width.

Coll. March, 1936, swamp near boat slough at the north end of Ohio street, Lawrence.

ORDER ULOTRICHALES

SUBORDER ULOTRICHINEAE

FAMILY ULOTRICHACEAE

Ulothrix tenuissima Kütz.

(Pl. IV, fig. 9)

Cells 15-19.4 mu wide. In young filaments the cells may be one fourth as long as wide. Chloroplast a wide band with two or more pyrenoids that does not completely encircle the cell.

Coll, Feb., 1935, 1936, Kaw river, Lawrence; 1937, Village creek, Chanute.

Stichococcus subtilis (Kütz.) Klecker

(Pl. IV, fig. 12)

Cells cylindrical, with a parietal, laminate chloroplast that does not encircle more than half of the cell and which contains one pyrenoid. The cells may be solitary, in short filaments of a few cells or longer filaments of several cells. The cells vary from 5-9 mu in length and average 7 mu in width. Solitary cells and the end cells of filaments have the outer end wall rounded.

Coll. March, 1935, 1936, 1937, Kaw river, Lawrence; April, 1935, 1937, swamp, Chanute.

Gleotila protogenita Kütz.

(Pl. IV, fig. 10)

Cells 3.5-4 mu thick, 1-2 times as long. Chloroplast large, as long as the cell, parietal and almost completely encircling the cell, without pyrenoids. The filaments are gradually constricted at the cross walls.

Coll. March, 1935, Jackman's pond, Lawrence.

Geminella ordinata West and G. S. West

(Pl. IV, fig. 15)

Filaments composed of cells equidistant from one another with a gelatinous tube; cells 5.8 mu thick. The individual cells are broadly rounded at the poles and contain a parietal, laminate chloroplast, having one pyrenoid, which encircles more than half of the cell.

Coll. April, 1936, Lawrence.

Hormidium flaccidum A. Br.

(Pl. IV, fig. 11)

Cells 12 mu thick, 1½ to 2 times as long and arranged in long filaments in standing water. Chloroplast parietal and nearly filling the length of the cell. Pyrenoids are scarcely discernible.

Coll. March, 1935, 1937, boat slough at north end of Ohio street, Lawrence. April, 1935, 1937, swamp, Chanute.

FAMILY MICROSPORACEAE

Microspora stagnorum (Kütz.)

(Pl. IV, fig. 14)

Filaments not constricted at the cross walls. Cells from 5 to 9.5 mu in width and from 1 to 4 times as long. Chloroplast parietal, covering both the ends and sides of the cell. It is an irregularly expanded sheet, perforate and reticulate and lacks pyrenoids.

Coll. Jan., 1936, from a field ditch near Blue Mound, Lawrence.

Microspora tumidula Hazen

(Pl. IV, fig. 13)

Cells almost cylindric, somewhat thinner at the cross walls, 6.7 to 9.5 mu wide and 1 to 2 times as long. Chloroplast somewhat thicker than that of the above species and covering a larger portion of the cell wall.

Coll. Dec., 1935, ditch on East Fifteenth street, Lawrence.

FAMILY CYLINDROCAPSACEAE

Cylindrocapsa geminella Wolle

(Pl. IV, fig. 16)

Cells in a single series within a thick gelatinous tube, or rarely irregularly arranged side by side within the same tube, each cell surrounded by several concentric strata. Width of the cells varies from 10 to 18 mu. The chloroplast is massive and contains a single pyrenoid which is generally obscured by numerous starch grains..

Coll. April, 1935, swamp, Chanute.

FAMILY CHAETOPHORACEAE

Stigeoclonium tenue (Ag.) Kütz.

Cells united to form a branching filament which usually grows attached to submerged objects. A prostrate portion which attaches the alga to the substrate is pseudoparenchymatous or irregularly branched and gives rise to numerous erect filaments which also branch. The ends of the branches are attenuated to sharp points and the branching is opposite. Cells 7 to 15 mu wide and 1 to 3 times as long; cylindrical or slightly swollen in the middle. The cells of the main axis which give rise to side branches are generally 10 mu long and 10 mu wide in the older portion of the filament. The chloroplasts of the older cells are transversely zonate and contain many pyrenoids; those of the smaller, younger cells encircle the length of the cell and contain a single pyrenoid.

Coll. April, May, 1935, 1936, 1937, Kaw river, Lawrence; 1935, 1936, swamp, Chanute.

Chaetophora incrassata (Huds) Hazen

(Pl. IV, fig. 19)

Colony an irregular elongate mass of intertwined filaments forming an axial strand from which arise numerous groups of short lateral branches, the whole embedded in a copious jelly and macroscopic in size. The ends of some of the branchlets taper out into long hyaline hairs, ending in a point. The chloroplast of the older, larger cells is a transversely zonate band with several pyrenoids; that of the younger cells fills the entire cell and contains one pyrenoid.

Coll. April, 1935, 1937, swamp, Chanute; 1935, Deer creek, Garnett.

Chaetophora elegans (Roth) Ag.

(Pl. IV, fig. 17)

Colony macroscopic, globular or hemispherical, depending on whether it is growing attached to submerged twigs or stones. The branches radiate throughout the gelatinous matrix from the point of attachment of the colony. The branching at the ends of the main filaments is fasciculate, but further within the colony they arise at widely separated points on the main filament. Cells of the main filament are 6 to 15 mu thick and 3 to 10 times as long.

Coll. March, April, May, 1935, 1936, 1937, Jackman's pond, East Fifteenth street quarry pool, Lawrence.

Draparnaldia plumosa (Vauch.) Ag.

(Pl. IV, fig. 20)

The plant body is macroscopic and divided into two types of branches. The primary branches are made up of large cylindrical or barrel-shaped cells 50 to 90 mu thick; while the lateral branches, which are 6 to 10 mu thick, grow in fasciculate groups and have the terminal cells of their filaments drawn out into long hyaline setae. The length of the cells of the primary filament is from 1 to 3 times the width and all the cells of the filament are about the same length. The chloroplast of the primary cells may be entire or reticulate, with smooth to toothed edges, and always contains several pyrenoids. The chloroplast of the lateral branch cells covers the entire wall surface of a cell and generally contains a single pyrenoid.

Coll. April, 1935, 1937, boat slough at north end of Ohio street, Lawrence; 1936, swamp, Chanute.

Draparnaldia Ravenelii Wolle

(Pl. IV, fig. 18)

The general description of this species is nearly the same as that of the foregoing species, but the two differ greatly in the general shape of the fascicle of lateral branches. Those of *D. plumosa* are lanceolate-elongate in outline, while those of *D. ravenelii* are orbicular in outline and much more densely branched. Also, the cells of the main filament of *D. plumosa* are generally longer than broad, while the cells of the main axis of *D. ravenelii* are shorter than broad to cuboidal.

Coll. April, 1935, roadside ditch, Labette.

Microthamnion Kuetzingianum Näg.

(Pl. V, fig. 1)

The plant body of this alga is densely branched with all the cells of the thallus of the same diameter. The branches originate as lateral outgrowths from the upper end of a cell and there is a marked tendency for the branches to be unilateral. There is a single, parietal, laminate chloroplast extending the whole length of the cell and partially encircling it which does not contain pyrenoids.

Coll. April, May, 1935, boat slough at north end of Ohio street, Lawrence.

Ulvella involvens (Savi) Schmidle

(Pl. V, fig. 3)

The thallus of this alga is composed of a sessile, orbicular pseudoparenchymatous layer of cells that grows epiphytically on other plants, animals or other objects. Young thalli are one cell in thickness, but older thalli may be several cells in thickness in the central portion. The cells are multinucleate and contain a single parietal, reticulate chloroplast with or without a pyrenoid.

Coll. March, 1936, on a turtle, Olathe.

Chaetopeltis orbicularis Berth

(Pl. V, fig. 6)

The thallus of this alga is discoid, usually one cell layer in thickness, and grows epiphytically on the filaments of other algae. The thallus has a thin

gelatinous sheath from which arise numerous long, delicate, gelatinous setae. The cells contain a single, parietal, laminate chloroplast which covers most of the cell's free face and has a single pyrenoid.

Coll. April, May, 1935, 1936, on *Cladophora glomerata* in Kaw river, Lawrence.

Aphanochaete repens A. Br.

(Pl. V, fig. 2)

The filaments of this alga grow epiphytically on the filaments of the larger algae and consist of simple or irregularly branched short filaments which taper at their extremities. The cells are globose to globose-cylindrical or barrel-shaped. Those in the middle of a filament have a single parietal, laminate chloroplast usually containing many pyrenoids. The chloroplasts of the cells at the extremities of the filaments contain only one pyrenoid. From the dorsal side of the cells one or more slender, hyaline, unicellular hairs may arise, tapering from a bulbous base to a fine point, and are probably modified branches.

Coll. March, April, 1935, 1936, on *Cladophora* sp., Kaw river, Lawrence.

FAMILY PROTOCOCCACEAE

Protococcus viridis Ag.

The cells of this alga grow either singly or in packets of two, four, or more. The solitary cells are spherical or ellipsoidal with a thick wall that is without a gelatinous envelope. The cells contain a single, parietal, laminate, chloroplast that is usually without pyrenoid, but may have one. It is commonly found growing epiphytically on the leeward side of trees from the prevailing wind, or on damp walls or surfaces.

Coll. throughout the years 1935, 1936, 1937, Lawrence.

FAMILY COLEOCHAETACEAE

Coleochaete scutata Bréb.

(Pl. V, fig. 4)

The thallus of this alga is an orbicular parenchymatous layer of cells, one cell layer in thickness, from certain cells of which arise single, long unbranched, cytoplasmic setae. The cells are angular by mutual compression and contain a single, parietal, laminate, chloroplast that partially or wholly encircles the protoplast and usually contains one large pyrenoid.

Came up in culture, 1936, Lawrence.

SUBORDER CLADOPHORINAE

FAMILY CLADOPHORACEAE

Cladophora glomerata (L.) Kütz.

(Pl. V, fig. 7)

This alga forms macroscopic, branching thalli which consist of large, multinucleate cells, five to twenty times as long as broad, and which are united end to end to form branching filaments that appear subdichotomous, but which are generally lateral in branching. The branches originate at the upper

end of a cell and are opposite. The thalli are usually sessile and grow attached to submerged objects. The cells of the main filament are 130 mu thick and those of the small branches are twenty-two mu thick at the least. A single, large, parietal, reticulate chloroplast covers the entire inner surface of the cell wall and contains numerous pyrenoids.

Coll. throughout the years 1935, 1936, 1937, Kaw river, Lawrence.

Rhizoclonium hieroglyphicum (Ag.) Kütz.

Cells 10 to 40 mu thick and two to eight times as long as broad; united to form long, unbranched filaments that are fastened to the substrate by unicellular, rhizoidal branches at the bases. Chloroplast a parietal, reticulate sheet that covers the entire cell wall and contains numerous pyrenoids which are placed at certain intersections of the reticulum. The cells are multinucleate.

Coll. 1935, swamp, Chanute; 1936, Jackman's pond, Potter's pond, Lawrence.

Rhizoclonium crispum Kütz.

(Pl. V, fig. 5)

The cells of this species are never more than twice their breadth in length. They are mostly 20 to 50 mu thick, very irregular in shape and have a membrane which is 3 to 4 mu thick. The filaments tend to grow in tangled masses and may be collected in such masses among other free-floating algae.

Coll. May, 1936, boat slough at north end of Ohio street, Lawrence.

Basicladia chelonum (Collins) Hoffm. and Tilden

(Pl. V, fig. 9)

This alga has been found growing on the carapace of turtles only, to which it is attached by rhizoidal outgrowth at the end of an elongated basal cell. The branching is from the base only or rather very rarely from a cell higher up on the erect filament, and the cross wall of the cell is generally a bit remote from the main filament. The cells are 35 mu thick or less and the chloroplast is like that of Cladophora.

Coll. fall, 1935, Newton; April, 1935, Olathe; July, 1937, Newton.

Pithophora kewensis Wittr.

(Pl. V, fig. 8)

This alga resembles Cladophora, but is markedly different by the presence of very dark terminal and intercalary akinetes, which are thicker-walled than the vegetative cells. In culture it grows most luxuriantly in the darker shaded portion of the container. The akinetes are visible to the unaided eye and give the filaments a beaded appearance. The filaments are less than 150 mu thick, those of the material determined being 105 mu thick and the akinetes being up to 140 mu thick. The branches, according to the published descriptions, originate just below the upper distal portion of a cell; however, in the material determined, the branches were, for the most part, arising from the mid portion of the cells, though they varied in this. Also, there were occasionally opposite branches.

Coll. 1935, Merrit Lake, Fort Leavenworth.

Pithophora varia Wille

Cells less than 100 mu thick; akinetes very variable in shape; otherwise the species is quite like *P. kewensis*.

Coll. July, 1937, Neodesha.

ORDER OEDOGONIALES

FAMILY OEDOGONIACEAE

Oedogonium crispum (Hass.) Wittr.

(Pl. V, fig. 11)

Oögonium single, egg-shaped, opening by a circular slit around the upper part to release the oöspore. Oöspore wall smooth. Vegetative cells 12-16 mu thick and generally from 3-4½ times as long as broad. Oögonium 37-43 mu thick, antheridial cells 8-14 mu thick and 7-12 mu long.

Coll. April, 1936, boat slough at north end of Ohio street, Lawrence.

Oedogonium globosum Nordst.

(Pl. V, fig. 10)

Oögonium single, subspherical; pore in the upper part. Oöspore subspherical, almost filling the oögonium; with a smooth membrane. Antheridium 1-7 celled. End-cell bristle-like. Vegetative cells 10-14 mu thick, 4-7 times as long. Oögonium 32-40 mu wide, 32-46 mu long; oöspores 30-37 mu wide, 28-37 mu long. Antheridial cells 9-12 mu wide, 4.5-8 mu long.

Coll. April, 1937, Green's pond, Lawrence.

Oedogonium cyathigerum Wittr. sec. Hirn

(Pl. VI, fig. 1)

Oögonium single, or 2-3 in a row, egg-shaped to quadratic-ellipsoidal with a pore in the upper part. Oöspore the same shape as the oögonium and filling it. Epispore smooth, mesospore longitudinally ribbed, the ribs distinct but sometimes anastomosed. Androsporangium many-celled. Dwarf males cup-shaped with an internal antheridium, bent, generally attached to the basal cell beneath an oögonium rather than to the oögonium. Vegetative cells 21-30 mu thick, 2-10 times as long. Cell just beneath the oögonium 42-48 mu wide, up to two times as long; oögonium 57-66 mu wide, 70-100 mu long. Oöspore 51-62 mu wide, 60-75 mu long. Androsporangial cell 23-30 mu wide, 12-30 mu long. Dwarf male 12-15 mu wide, 50-58 mu long.

Coll. June, 1937, Chetopa creek, Altoona.

Bulbochaete varians Wittr. sec. Hirn

(Pl. VI, fig. 2)

Gynandrosporous. Oögonium ellipsoidal, terminal or beneath a terminal hair, or under an androsporangium or under a vegetative cell which bears an androsporangium. Androsporangium elongate, epigynous or nearly so, 1-2 celled. Dwarf males with an outer 1-3 celled antheridium, attached near to or on the oögonium. Vegetative cells 17-22 mu thick 1¼-1½ times as long. Oögonium 30-36 mu wide, 44-54 mu long. Androsporangial cells 14-17 mu wide, 14-18 mu long. Stalk of the dwarf male 14-16 mu thick, 24-27 mu long. Antheridial cells 8-10 mu wide, 6-7 mu long.

Coll. June, 1937, Green's pond, Lawrence.

ORDER ULVALES

FAMILY SCHIZOMERIDACEAE

Schizomeris Leibleinii Kütz.

(Pl. VI, fig. 3)

Filaments of this alga consist of an elongate basal cell with a discoid holdfast, a region in which cell division has been in one plane and a region in which cell division has been in two planes so as to make a solid cylinder of cells. The chloroplast in the basal cell and first region is a ulotrichoid type and encircles about two thirds of the protoplast. They usually contain several pyrenoids. The chloroplast of the cells in the cylindrical portion of the thallus is more massive and fills most of the protoplast. The apical cell of a thallus is acute. Quadriflagellate zoöspores are formed in either terminal or intercalary sporangia, but always in the upper portion of the thallus. The thick lateral walls of the simple filament persist as rings after the vertical division of the cells and their multiplication to form the solid cylindrical thallus.

Coll. June, 1937, drainage ditch in Haskell bottoms, Lawrence.

ORDER SCHIZOGONIALES

FAMILY SCHIZOGONIACEAE

Schizogonium murale Kütz.

(Pl. VI, fig. 6)

Thallus a simple, cylindrical filament of cells within a sheath. Cells wider than long, 7-7.5 mu wide, 5-5.5 mu long. They contain a single axial, stellate chloroplast which has one pyrenoid.

Coll. April, 1937, Green's pond, Lawrence.

ORDER CHLOROCOCCALES

FAMILY CHLOROCOCCACEAE

Chlorococcum infusionum (Schrank) Menegh.

(Pl. VI, fig. 5)

Cells spherical; either solitary or aggregated in a gelatinous mass, 10-15 mu in diameter. The chloroplast of young cells is a massive cup and contains one pyrenoid; in older cells it becomes diffuse and contains several pyrenoids. The cell is at first uninucleate, but contains many nuclei just before reproduction. Reproduction is by zoöspores.

Coll. April, May, 1935, 1937, field ditch near Blue Mound, Lawrence.

Chlorococcum humicola (Näg.) Rab.

(Pl. VI, fig. 4)

Cells very variable in size, 2-3 mu seldom up to 25 mu in diameter, single or in small groups. A single parietal chloroplast which contains one pyrenoid is present.

Coll. Dec., March, 1935, 1936, on damp soil in Botany department greenhouse.

Golenkinia radiata Chod.

(Pl. VI, fig. 8)

Cells solitary, spherical, thin-walled, the wall bearing many long, delicate setae that are not thickened in the portion next to the wall. Chloroplast cup-shaped and containing one pyrenoid. Reproduction by autospores.

Coll. March, April, 1937, small aquarium, Lawrence.

FAMILY ENDOSPHAERACEAE

Chlorochytrium lemnae Cohn

(Pl. VI, fig. 7)

Cells endophytic in the tissues of species of Duckweed or Lemna, irregularly globose to ellipsoidal, with relatively thin, homogenous cell walls. Chloroplast at first parietal and cup-shaped, later becoming radially vacuolate and filling the entire cell lumen.

Coll. May, 1935, growing in *Lemna minima,* Lawrence.

FAMILY CHARACIACEAE

Characium ornithocephalum A. Braun

(Pl. VI, fig. 9)

This alga may be epiphytic on other algae, submerged sticks, stones or on aquatic animals. The material collected was growing on Oedogonium. The cells are roughly half-moon-shaped or as the specific name suggests, they are somewhat the shape of a bird head. Cells without stalk are 25-33 mu long and generally half as thick. The cells are uninucleate and have a parietal laminate chloroplast which contains one pyrenoid. The material collected has been placed tentatively as this species since there was no other that had the same peculiar cell shape and the measurements were approximately the same. The material determined varies from 15-30 mu in length and 5-10 mu in width. The stalk of the collected material was very short compared to the stalk figured in Pascher for *C. ornithocephalum.*

Coll. May, 1935, on *Oedogonium* sp., boat slough at north end of Ohio street, Lawrence.

Characium angustum A. Braun

(Pl. VI, fig. 10)

Cells 22.5 mu long, 7.5-9 mu wide. The material determined as of this species fits the description but not the figure in Pascher for this species. In culture a dense growth was obtained on the wall of the container from which pure mounts could be made. The disk at the end of the stipe was very distinct and the rounded base of the cell where it changed abruptly into stipe was also clear. This feature in itself does not fit any of the described species in Pascher, nor any of the figures.

Coll. April, May, 1935, on *Oedogonium* sp., Jackman's pond, Lawrence.

Characium Naegelii A. Braun

(Pl. VI, fig. 11)

Young cells linear-lanceolate; older cells almost elliptic, with a short stipe that is not broadened into a disk holdfast at the base. Cells 20-42 mu long, 7-18 mu wide; stipe 4 mu long.

Coll. spring, 1936, boat slough at north end of Ohio street, Lawrence.

Characium Braunii Breug.

(Pl. VI, fig. 12)

Cells 25-32 mu long, 6.5-13 mu wide with a short stipe which is a quarter to a fifth as long as the cell body. The cell body is equally attenuated at each end, linear-lanceolate. The basal disk may be colored brown.

Coll. spring, 1937, on Cladophora, Kaw river dam, Lawrence.

FAMILY HYDRODICTYACEAE

Pediastrum Boryanum (Turp.) Menegh.

(Pl. VI, fig. 13)

Cells united to form a coenobium one cell layer in thickness, without any perforations or space between calls. The coenobia may contain 4-128 cells. The marginal cells have two projections and the cells in general measure up to 40 mu in diameter.

Coll. April, May, 1935, 1936, Jackman's pond, quarry pool on East Fifteenth street, Lawrence; Feb., 1935, Newton.

Pediastrum Boryanum (Turp.) Menegh. var. *brevicorne* Al. Braun

(Pl. VI, fig. 14)

Coenobium with 8-32 cells. Cells up to 35 mu wide. Border cells rounded out. Processes short, 4 mu long, 2-3 mu wide. Two forms occur; smooth (forma *glabra*), punctate (forma *punctata*).

Coll. April, 1936, Jackman's pond, Lawrence.

Pediastrum Boryanum (Turp.) Menegh. var. *longicorne* Reinsch

(Pl. VI, fig. 19)

Coenobium eight or more celled, the inner cells 5-6 sided. The marginal cells have two abruptly projecting, slender processes from each cell.

Coll. April, 1937, swamp by the boat slough at the north end of Ohio street, Lawrence.

Pediastrum duplex Meyen var. *cornutum* Raciborski

(Pl. VI, fig. 15)

Number of cells in the coenobia variable, 4-8-16, etc. The processes of the marginal cells are very abrupt and smooth with blunt tips.

Coll. May, 1935, Jackman's pond, Lawrence.

Pediastrum duplex Meyen var. *reticulatum* Lager.

(Pl. VI, fig. 16)

Coenobium 8-16-celled, the cells almost H-shaped, perforations very large; marginal cells 12-18 mu in diameter.

Coll. spring, 1936, Lawrence.

Pediastrum duplex Meyen var. *gracillimum* W. and G. S. West

(Pl. VI, fig. 18)

Coenobium up to 87 mu in diameter. Marginal cells very deeply incised by the presence of two long, slender, blunt-tipped processes from each cell. The interior cells of the coenobium are four-armed.

Coll. spring, 1936, field ditch near Blue Mound, Lawrence.

Pediastrum simplex (Meyen p. p.) Lemm. var. *radians* Lemm.

(Pl. VII, fig. 3)

Marginal cells with one process; center of the coenobium one large opening so that the coenobium is merely a ring of marginal cells.

Coll. April, 1935, Jackman's pond, Lawrence.

Pediastrum clathratum (Schroeter) Lemm.

(Pl. VII, fig. 2)

Coenobium with large and small perforations. The middle cells many-sided and the marginal cells forming an outer ring, each cell of which has a long process which is slightly concave at the tip.

Coll. spring, 1935, quarry pool on East Fifteenth street, Lawrence.

Pediastrum clathratum (Schroeter) Lemm. var. *duodenarium* (Bailey) Lemm.

(Pl. VII, fig. 4)

Coenobium 16-celled with five cells in the middle and the remainder forming a ring about them.

Coll. spring, 1935. Jackman's pond, Lawrence.

Pediastrum duplex Meyen var. *clathratum* A. Braun

(Pl. VII, fig. 1)

Coenobium 8-64-celled. Cells 20 mu wide, 25 mu long. Middle cells quite different from the marginal cells, their walls being rounded out. Perforations quite large.

Coll. June, 1937, Moulton's lake, Neodesha.

Pediastrum tetras (Ehrenb.) Ralfs

(Pl. VI, fig. 17)

Coenobium 4 to 16-celled. Marginal cells with a narrow sinus which reaches to the middle of the cell. Middle cells many-sided, each with a narrow slit on one side.

Coll. May, 1937, boat slough at north end of Ohio street, Lawrence.

Hydrodictyon reticulatum (L.) Lagerh.

Coenobium made up of cells united in such a fashion as to make a closed net in which the meshes are generally six-sided. The cells are at first uninucleate, but become multinucleate as growth in size continues. The chloroplast is at first zonate and contains one pyrenoid; later in the older cells it becomes reticulate with many pyrenoids. Reproduction either by biflagellate zoöspores or biflagellate gametes.

Coll. spring, 1935, 1936, Merrit Lake, Fort Leavenworth.

FAMILY COELASTRACEAE

Coelastrum reticulatum G. S. West

(Pl. VII, fig. 7)

Coenobium spherical, composed of tetrad-groups of cells, the groups united by long processes leaving large spaces in between. The cells of a group of four

are closely packed with little if any space between individual cells. Cells 6-10 mu in diameter.

Coll. June, 1937, boat slough at north end of Ohio street, Lawrence.

Coelastrum microporum Näg.

(Pl. VII, fig. 6)

Coenobium a hollow sphere of 4, 8, 16, 32 up to 128 cells. Cells spherical, 6-27 mu in diameter, walls smooth, united by short processes. Chloroplast of young cells cup-shaped with one pyrenoid, later in older cells becoming diffuse and filling the entire cell cavity.

Coll. spring, 1935, boat slough at north end of Ohio street, Lawrence; June, 1937, Chetopa creek, Altoona.

Coelastrum sphaericum Näg.

(Pl. VII, fig. 5)

Cells more ovoid than spherical, closely appressed, the space between the cells being at the most one half the diameter of the cells. Cells up to 25 mu in diameter.

Coll. spring, 1935, boat slough at north end of Ohio street, Lawrence; June, 1937, Chetopa creek, Altoona.

FAMILY OOCYSTACEAE

Chlorella conductrix Brandt

(Pl. VII, fig. 8)

Cells solitary, endophytic in protozoa, spherical. They are commonly found living within the cells of Hydra, Stentor and Paramecium.

Coll. 1935, 1936, 1937, in Paramecium and Chilodon, Potter's pond, Jackman's pond, Lawrence.

Westella botryoides (W. West) de Wildm.

(Pl. VII, fig. 9)

Cells spherical to subspherical, quadrately grouped in fours or eights in irregular free-floating colonies containing a variable number of cells up to 100. The groups of cells are held together by old mother-cell wall remains. Cells 3.5-8 mu in diameter. Chloroplasts parietal and cup-shaped or entirely filling the cell. There may or may not be a pyrenoid.

Coll. June, 1937, drainage ditch in Haskell bottoms, Lawrence.

Dictyosphaerium pulchellum Wood

(Pl. VII, fig. 10)

Cells spherical, united by dichotomously forked threads, the persisting mother-cell walls of previous generations. The whole is embedded in a copious, colorless, gelatinous sheath. Chloroplast parietal and cup-shaped with one pyrenoid. Cells 5-9 mu in diameter.

Coll. March, 1936, Lawrence. In Botany greenhouse pool.

Trochiscia pachyderma (Reinsch) Hansg.

(Pl. VII, fig. 11)

Cells solitary, spherical, 12-19 mu in diameter. Inner layer of the cell wall strongly warty with 7-20 warts with blunt outer surfaces.

Coll. June, 1937, Moulton's lake, Verdigris river, Neodesha.

Excentrosphaera viridis G. T. Moore

(Pl. VII, fig. 12)

Cells ellipsoidal to subspherical, 22-55 mu in diameter, with numerous angular chloroplasts that are peripheral in arrangement. The cell wall is irregularly thickened and often stratified in the thickened portion. Reproduction is by the formation of aplanospores which are released through a pore in the cell wall.

Coll. July, 1937, Green's pond, Lawrence.

Oöcystis parva W. and G. S. West

(Pl. VII, fig. 14)

Cells 2, 4, or 8, surrounded by the partially gelatinized and greatly expanded mother-cell wall. Individual cells 6-12 mu long, 4-7 mu wide; rather narrowly elliptic with the poles pointed, but without nodular thickenings. Chloroplasts 2 or 3 and parietal, with or without pyrenoids. Cells may be solitary by escape from the mother-cell wall.

Coll. April, 1936, Green's pond, Jackman's pond, Lawrence.

Oöcystis elliptica W. West

(Pl. VII, fig. 15)

Cells elongate-elliptic, without thickened poles, 24-25 mu long, 11-11.5 mu wide, solitary or in four- or eight-celled aggregates within the old mother-cell wall.

Coll. July, 1937, drainage ditch in Haskell bottoms, Lawrence.

Dimorphococcus lunatus A. Br.

(Pl. VII, fig. 16)

Cells arranged in tetrads, the tetrads united to one another in irregular free-floating colonies by the branching remains of old mother-cell wall. Cells oval to elliptic, 10-20 mu long.

Coll. July, 1937, Green's pond, drainage ditch in Haskell bottoms, Lawrence.

Closteridium lunula (Reinsch) Wille ?

(Pl. VII, fig. 17)

The specimens of this alga were very few in culture and collected only once. They all measured the same, being 12 mu wide and 60.8 mu long, and all were lunate in shape with the sharply pointed or spined tips bent in opposite directions. This is being tentatively identified as *Cl. lunula* since the description of that species fits with the exception of dimensions. *Cl. lunula* is 9-12 mu wide and 25-31 mu long.

Coll. June, 1937, drainage ditch in Haskell bottoms, Lawrence.

Ankistrodesmus falcatus (Corda) Rolfs var. *acicularis* (A. Braun) G. S. West

(Pl. VII, fig. 19)

Cells solitary, 1.5-3.5 mu thick, 20-80 mu long, almost straight, but may have a very slight arc. Chloroplast parietal and with or without a pyrenoid.

Coll. 1935, 1936, 1937, Lawrence. Comes up in any culture.

Ankistrodesmus falcatus (Corda) Rolfs var. *mirabile* W. and G. S. West

(Pl. VII, fig. 18)

Cells solitary, of the same measurements as the above variety, straight in the main portion with the attenuated ends suddenly curved or they may be spirally twisted, not quite making a complete turn.

Coll. 1935, 1936, 1937, Lawrence. Comes up in any culture.

Schroederia setigera (Schröder) Lemm.

(Pl. VII, fig. 18)

Cells solitary, with a long slender spine at each end, 2.5-10 mu wide, 22.5-52.3 mu long without the spines, narrowly elliptic and sometimes slightly lunate.

Coll. April, May, 1935, state lake, Tonganoxie.

Selenastrum gracile Reinsch.

(Pl. VIII, fig. 1)

Cells arcuate to lunate with sharp poles, aggregated in groups of 4, 8, or 16 with their convex faces opposed. There is no colonial gelatinous sheath. Cells 19-28 mu long, 4-5 mu wide.

Coll. June, 1937, Chetopa creek, Altoona.

Kirchneriella contorta (Schmidle) Bohlin

(Pl. VIII, fig. 2)

Cells are irregularly curved cylinders, blunt on both ends, .7-2 mu wide, 8-10 mu long. Chloroplast single and parietal with one pyrenoid. Cells grouped in fours or eights in a homogenous matrix.

Coll. May, 1935, April, 1936, state lake, Tonganoxie.

Kirchneriella lunaris (Kirchner) Mob.

(Pl. VIII, fig. 3)

Cells lunate with the extremities pointed; 3-5 mu wide, 6-10 mu long. Chloroplast single and parietal with one pyrenoid. Cells grouped in fours in a colonial matrix.

Coll. May, 1936, Jackman's pond, Lawrence.

Tetraëdron caudatum (Corda) Hansg.

(Pl. VIII, fig. 4)

Cells solitary, five-lobed with a deep sinus, the lobes rounded and tipped with a spine 3 mu long; 13-23 mu in diameter.

Coll. Sept., 1935, Jackman's pond, Lawrence.

Tetraëdron punctulatum (Reinsch.) Hansg.

(Pl. VIII, fig. 6)

Cells solitary, four-sided, the sides more or less equal, corners rounded and the margin wavy. The corners may have the semblance of a short, blunt spine. Cells 18-21 mu wide. Chloroplasts one to many, parietal and disk-shaped, with or without a pyrenoid. Cell wall may be slightly warty.

Coll. May, 1936, Jackman's pond, Lawrence.

Tetraëdron minimum (Al. Braun) Hansg.

(Pl. VIII, fig. 5)

Cells more or less square, the wall smooth, the corners rounded and more or less deeply indented between corners. Cells 6-10 mu wide, 3-6 mu thick.

Coll. March, 1937, Village creek swamp, Chanute.

Tetraëdron trigonum (Naegeli) Hansg. Var. *minor* Reinsch

(Pl. VIII, fig. 9)

Cells triangular, the sides indented and attenuating at the apices into sharp spines, 10-14 mu wide.

Coll. July, 1937, drainage ditch in Haskell bottoms, Lawrence.

Tetraëdron proteiforme (Turn.) Brunn.

(Pl. VIII, fig. 11)

Cells two- or three-cornered, the corners drawn out into fine spines. Cells twisted so that one pair of spines is opposite in direction to the other pair. 36-65 mu long.

Coll. July, 1937, stock pool in the sand hills, Burrton.

Tetraëdron trilobatum (Reinsch) Hansg.

(Pl. VIII, fig. 7)

Cells triangular, sides deeply indented and the corners broadly rounded. Cells 25 mu wide.

Coll. July, 1937, stock pool in the sand hills, Burrton.

Tetraëdron tumidulum (Reinsch) Hansg.

(Pl. VIII, fig. 10)

Cells tetrahedral, sides somewhat indented, corners broadly rounded. 20-60 mu wide.

Coll. June, 1937, Chetopa creek pool, Altoona.

Tetraëdron pentaëdricum W. and G. S. West

(Pl. VIII, fig. 8)

Cells 5-lobed, sides concave, lobes rounded and each bearing a short, stout, slightly bent spine. Cells 10-15 mu in diameter without the spines. Spines 4.5-5.5 mu long.

FAMILY SCENEDESMACEAE

Scenedesmus denticulatus Lagerh.

(Pl. VIII, fig. 18)

Cells egg-shaped to lance-elliptic with two or three teeth on each end. Cells 4-11 mu wide, 6-15 mu long.

Coll. July, 1937, Chetopa creek pool, Altoona.

Scenedesmus obliquus (Turp.) Kütz.

(Pl. VIII, fig. 12)

Coenobium of four or eight cells in one or two rows. Cells pointed at the ends, 4-35 mu long, 2.5-10 mu wide. Chloroplast parietal and contains one pyrenoid.

Coll. 1935, 1936, 1937, in most any collection, Lawrence.

Scenedesmus bijuga (Turp.) Lagerh.

(Pl. VIII, fig. 14)

Cells oval to ellipsoidal with broadly rounded ends; 4-8 in a coenobium in one or two rows. Cells 4-7 mu wide, 7-18 mu long.

Coll. 1935, 1936, 1937, Jackman's pond, Lawrence.

Scenedesmus quadricauda (Turp.) Bréb.

(Pl. VIII, fig. 15)

Coenobium 4-celled, the cells ovoid with rounded poles. End-cells each with two long spines. Cells 3-15 mu wide, 8-42 mu long.

Coll. Common in all cultures spring and summer, Lawrence.

Scenedesmus abundans (Kirch.) Chod.

(Pl. VIII, fig. 16)

Coenobium 4-celled; cells ovoid and broadly rounded at the poles. End-cells with 2-3 radiating spines between two long spines that are similar in position to those of S. quadricauda. Cells 3-12 mu wide, 6-35 mu long.

Coll. April, 1935, Oct., 1936, Jackman's pond, Lawrence.

Scenedesmus dimorphus (Turp.) Kütz.

(Pl. VIII, fig. 13)

Cells long-pointed; the middle ones somewhat lens-shaped, the end ones lunate; 6-7 mu wide, 30-40 mu long. Coenobium 4-celled.

Coll. May, 1935, 1936, Jackman's pond, Lawrence.

Crucigenia rectangularis (Näg.) Gay

(Pl. VIII, fig. 17)

Cells in groups of four to form a coenobium which is free-floating. The cells are quadrately arranged with a large space in the middle. They are ellipsoidal in shape and contain from one to four parietal, discoid chloroplasts. Cells 4-5 mu wide, 4-6 mu long.

Coll. Oct., 1936, Dightman's crossing, Wakarusa, Lawrence.

Crucigenia tetrapedia (Kirch.) W. and G. S. West

(Pl. VIII, fig. 23)

Coenobium 4-celled, generally joined into 16-celled compound coenobia. Cells triangular and closely adhering to one another. The outer wall of the cells is slightly concave. Cells 4.8 to 9.5 mu long.

Coll. July, 1937, Village creek, Chanute.

Tetrastrum elegans Playfair

(Pl. VIII, fig. 22)

Coenobium 4-celled; the cells closely packed and each bearing a single long, slender spine up to three times the cell in length. Cells 4.9 mu wide.

Coll. July, 1937, stock pool in sand hills, Burrton.

Tetrastrum apiculatum (Lemm.) Schmidle

(Pl. VIII, fig. 21)

Coenobium 4-celled; cells oblong, almost three-cornered, on the inside of the outer poles bearing a very short, blunt spine. Cells 2.5-5 mu wide, 4-7 mu long.

Coll. July, 1937, stock pool in sand hills, Burrton.

Actinastrum gracillimum G. M. Smith

(Pl. VIII, fig. 19)

Coenobium of 5, 8 or 16 cells; cells elongate and radiate in arrangement, only slightly tapered at the poles, 3.3 mu wide, 9.9-13.2 mu long.

Coll. July, 1937, stock pool in sand hills, Burrton.

Actinastrum Hantzschii Lagerh. var. *javanicum* Bernard

(Pl. VIII, fig. 20)

Coenobium of 4-16; cells elongate and radiate in arrangement, poles of the cells tapering to a blunt or acute apex, 3.3 mu wide, 16.5 mu long.

Coll. July, 1937, stock pool in sand hills, Burrton.

Micractinium pusillum Fresenius

(Pl. VIII, fig. 24)

Cells spherical, united into 4-celled coenobia which are always in turn united with many coenobia to form multiple coenobia. The free face of each cell in a coenobium bears from one to seven delicate setae which are many times the cell diameter in length. Cells 6.6 mu in diameter.

Coll. July, 1937, stock pool in sand hills, Burrton.

Errerella bornhemiensis Conrad

(Pl. VIII, fig. 25)

Cells spherical, united into 4-celled coenobia in which the cells are pyramidal in arrangement. Multiple coenobia are the rule with over 100 cells, the number usually being a multiple of four, 16, 64, to 256. The free face of each cell bears a single, long, stout spine. Cells 3-7 mu in diameter.

Coll. July, 1937, drainage ditch in Haskell bottoms, Lawrence.

ORDER SIPHONALES

FAMILY VAUCHERIACEAE

Vaucheria geminata (Vaucher) D. C.

(Pl. IX, fig. 1)

Thallus composed of irregularly branched, coenocytic filaments from which the reproductive bodies are cut off by cross walls. Two oögonia are borne laterally at the end of a short side branch with an antheridium rising between them. Ripe oöspores 64.5-190 mu long, 52.5-225 mu wide. Chloroplast discoid, numerous and embedded in a parietal sheet of cytoplasm.

Coll. 1935, 1936, 1937, boat slough at north end of Ohio street, Lawrence.

Vaucheria sessilis (Vaucher) D. C.

(Pl. IX, fig. 2)

Similar to the above species except that the antheridia and oögonia arise next to each other and are sessile on the main filament. The particular material found is Pascher's *forma clavata,* which has erect oögonia with the receptive spot on the top. Oöspores 66-88.5 mu long, 49.5-66.5 mu wide.

Coll. April and May, 1937, Jackman's pond, Lawrence.

ORDER ZYGNEMATALES

FAMILY ZYGNEMATACEAE

Zygnema insigne (Hassall) Kütz.

(Pl. IX, fig. 3)

Vegetative cells 26-30 mu wide. Conjugation either lateral or scalariform, the cells concerned swollen or only the cell acting as zygote container swollen. Zygospore ovoid, 26 mu wide, 32 mu long. Exospore thin, smooth and colorless. Mesospore thick, brown and smooth.

Coll. Sept., May, 1935, 1936, quarry pool on East Fifteenth street, Lawrence.

Spirogyra protecta Wood

(Pl. IX, fig. 4)

Vegetative cells 20-25 or 36-40 mu wide. Conjugation scalariform. One chloroplast is present in each cell. Cross walls replicate. Neither of the conjugating cells becomes swollen. Zygote ovoid; exospore thick, colorless and of two layers. The outer layer thin and smooth, the inner thick and ornamented with circular depressions which make the intervening areas stand out as spines. Zygote 36 mu wide, 72 mu long.

Coll. April, 1936, quarry pool on East Fifteenth street, Lawrence.

Spirogyra punctiformis Transeau

(Pl. IX, fig. 6)

Vegetative cells 27-30 mu wide, with one or two chloroplasts, end walls not replicated. Cell containing the zygote becomes very swollen. Zygote 40-48 mu wide, 60-110 mu long; exospore colorless, thick and smooth, mesospores fairly thick, yellow and minutely pitted.

Coll. April, 1935, Lawrence.

Spirogyra malmeana Hirn

(Pl. IX, fig. 5)

Vegetative cells 76-91 mu wide, end-walls not replicated, three or four chloroplasts to a cell. Conjugation scalariform, the cells containing the zygote not becoming swollen. Zygote ellipsoidal, 54 mu wide, 82 mu long. Exospore thin, smooth and colorless. Mesospore, thick, brown and ornamented with irregular and branched ridges which do not form a net on the outer surface of the mesospore. There are peculiar crystals present in the cytoplasmic strands that are shaped like a cross.

Coll. April, May, 1936, Potter's pond, Lawrence, roadside ditch, Lecompton.

Spirogyra decimina (Müll.) Czurda emend.

(Pl. IX, fig. 13)

Vegetative cells 31-33 mu wide, with replicate end-walls, and with one chloroplast. Conjugation scalariform, the canal being formed largely by one of the conjugating cells. Zygote containing cell scarcely swollen. Zygote 34-62 mu wide, 56 to 124 mu long. Exospore thin, smooth and colorless. Mesopores thick, yellow and marked with an equatorial line running lengthwise.

Coll. June, 1937, boat slough at north end of Ohio street, Green's pond, Lawrence.

FAMILY MESOTAENIACEAE

Spirotaenia parvula Arch.

(Pl. IX, fig. 7)

Cells solitary, fusiform, with a single, parietal and spirally twisted chloroplast. Cells 25 mu wide, 145 mu long.

Coll. May, 1936, East Fifteenth street, quarry pool, Lawrence.

Netrium digitus (Ehrenb.) Itz. and Rothe

(Pl. IX, fig. 9)

Cells large, 216-264 mu long, 69-72 mu wide, oblong-elliptic, gradually attenuated from the middle to the rounded or rounded-truncate apices. Chloroplast axial with 5-7 radiating plates which are deeply serrate on the outer margins, two to a cell. Cell wall smooth.

Coll. June, 1937, Moulton's lake, Neodesha.

Roya obtusa (Bréb) W. and G. S. West

(Pl. IX, fig. 8)

Cells cylindrical, very slightly curved, apices broadly rounded, 22-120 mu long, 12-15 mu wide. Chloroplast a long band the entire length of the cell and containing 2-8 pyrenoids, and with a notch at the middle.

Coll. June, 1937, Chetopa creek, Altoona.

FAMILY DESMIDIACEAE

Closterium moniliforme (Borg.) Ehrenb.

(Pl. IX, fig. 12)

Cells solitary, lunate, poles attenuated to blunt points. Chloroplasts with longitudinal ridges and a row of pyrenoids. Cells 291 mu from tip to tip and 55.7 mu wide at the isthmus.

Coll. 1935, 1936, 1937, spring, abundant in Green's pond, Jackman's pond, East Fifteenth street quarry pool, Lawrence.

Closterium acerosum (Schrank) Ehrenb.

(Pl. IX, fig. 11)

Cells linear-lanceolate with the ends very slightly curved; 343 mu long, 25.7 mu wide at the isthmus.

Coll. May, 1936, Green's pond, Lawrence.

Closterium subulatum (Kütz.) Breb.

(Pl. IX, fig. 10)

Cells small, slightly curved, 148-150 mu long, 9-11 mu wide; apices gradually attenuated from the middle, subtruncate to rounded on the end. Cell wall smooth. Chloroplast with three pyrenoids.

Penium curcubitum Biss.

(Pl. IX, fig. 15)

Cells aggregated in a copious jelly. Individual cells with a very shallow constriction at the isthmus, wall smooth; 38 mu long, 19 mu wide. Chloroplast in each semicell two or four lobed. Cells ovate-elliptic.

Coll. April, 1937, Santa Fe pond, Chanute.

Pleurotaenium Ehrenbergii (Bréb.) De Bary

(Pl. IX, fig. 14)

Cells linear with truncated apices and with a constriction at the isthmus, 384-437 mu long, 30-33 mu wide. Semicells inflated and undulated at the base. Cell wall punctate, apices with 7-8 tubercles in a ring about the margin. Chloroplasts numerous, parietal, longitudinal bands, each containing many pyrenoids.

Coll. June, 1937, Chetopa creek, Altoona.

Euastrum verrucosum Ehrenb.

(Pl. IX, fig. 22)

Cells moderately large, subhexagonal, somewhat longer than broad, deeply constricted, sinus narrowly linear; semicells three-lobed, interlobular incisions deep but open; polar lobe widely cuneate, angles rounded and granulate, apex retuse; lateral lobes about as wide as the polar lobe, cuneate and bilobulate, lower lateral lobule subconical, rounded, granulate, and horizontally directed, upper lateral lobule granulate, divergent upward and outward; semicells with three large protuberances across the broadest part, the central one the largest, each protuberance with large granules in concentric circles; cell wall granulate. Cells 84-90 mu long, 72-81 mu wide.

Coll. June, 1937, Chetopa creek, Altoona.

Cosmarium circulare Reinsch

(Pl. IX, fig. 19)

Cells orbicular with two narrow sinuses. Apex of the sinus not inflated; cell wall not ornamented. Cells 48.3 mu long and nearly the same in width.

Coll. Oct., 1935, East Fifteenth street quarry pool, Lawrence.

Cosmarium punctulatum (Nordst.) Borg.

(Pl. IX, fig. 18)

Cells orbicular, flattened at the poles; minutely scalloped in outline, punctate with groups of punctae on the cheeks. Cells 33.3 mu long, 30 mu wide.

Coll. May, 1936, boat slough at north end of Ohio street, Lawrence.

Cosmarium reniforme (Ralfs) Arch.

(Pl. IX, fig. 16)

Cells flattened-orbicular, 45.6-55 mu long, 49.4-54 mu wide. Semicells reniform in shape so that a definite pore is seen, on each side of the isthmus, which is triangular in shape. Wall covered with coarse granules in rows. In side view each semicell is circular, in vertical view elliptic with slight swellings on each side at the middle.

Coll. April, 1936, Green's pond, Lawrence; June, 1937, Moulton's lake, Neodesha.

Cosmarium polymorphum

(Pl. IX, fig. 17)

Cells orbicular with the poles flattened and the wall at these places smooth and even. The remainder of the wall on each semicell from the pole to the sinus is crenate in outline. Sinus inflated slightly at the apex. Cells 8 mu long, 8 mu wide.

Coll. May, 1936, Lawrence.

Cosmarium Schliephackeanum Grün. (Taft 1931)

(Pl. IX, fig. 21)

Cells small, angular, 15 mu long, 12-15 mu wide, deeply constricted, sinus narrowly linear, not inflated at the apex; semicells transversely-hexagonal, angles not rounded, apex broadly truncate. Vertical view narrowly elliptic with dull or sharp protuberance on each side at the middle. One chloroplast and one pyrenoid in each semicell.

Coll. May, June, 1936, Jackman's pond, Lawrence.

Cosmarium pseudobroomei Wolle (Hylander 1928)

(Pl. IX, fig. 20)

Cells square to rectangular with the angles rounded, 33 mu long, 38-40 mu wide, 13 mu thick, walls densely granular with very small granules, deeply constricted, sinuses narrow and dilated at the apices. Semicells rectangular in outlines, angles rounded, sides straight or slightly convex, apex straight. Lateral view; semicells orbicular. Vertical view; rectangular-elliptic. Chloroplast in each semicell, axial and containing two pyrenoids.

Coll. June, 1937, Green's pond, Lawrence; July, 1937, Moulton's lake, Neodesha.

Cosmarium polygonum (Näg.) Arch.

(Pl. X, fig. 1a)

Cells 21 mu long, 15 mu wide, 5.7 mu thick, deeply constricted, sinus narrow and not dilated at the apex. Semicells six-sided in outline, angles rounded, sides and apex slightly concave. One axial chloroplast and one pyrenoid in each semicell. Lateral view narrowly or linear elliptic with the poles rounded-truncate. There is a sharp inflation bearing a granule, on each side a little

above the constriction. Vertical view narrowly elliptic with the poles either rounded or rounded-truncate, a sharp inflation and granule in the middle on each side.

Coll. July, 1937, Chetopa creek, Altoona.

Two other specimens of *Cosmarium* were collected which, though not fulfilling the dimensional requirements of the description of *C. Polygonum* and not the same shape, seem to be variants of *C. polygonum*. They each have the same type of inflation or granular protuberance, sinuses, chloroplast and cell wall as *C. polygonum* and differ only in shape.

Variant 1

(Pl. X, fig. 1b)

Cells rectangular to square with the corners cut off, 19 mu long, 15 mu wide, 5.7 mu thick. Semicells six-sided in outline, the corners rounded, wall smooth. One chloroplast and one pyrenoid in a semicell. Sinuses deep, narrow and not inflated. Lateral view: semicells rectangular with the corners rounded and the broad faces just above the constriction inflated and bearing a blunt protuberance. Vertical view: rectangular with the corners rounded; middle inflated and bearing a blunt protuberance in the center on each side.

Coll. June, 1937, Altoona.

Variant 2

(Pl. X, fig. 1c)

Cells rectangular and sharp-angled, 11.4 mu long, 9.5 mu wide. Semicells hexagonal with sharp corners, containing each one chloroplast and one pyrenoid. Sinuses deep and not inflated at the apices. Lateral view: semicells ovoid, each with a centrally located blunt point on the broad face. Vertical view: elliptic with the poles rounded-truncate and a blunt point in the center on each side.

Coll. June, 1937, Neodesha.

Cosmarium granatum Bréb.

(Pl. X, fig. 2a)

Cells subrhomboid-elliptic, 27-45 mu long, 21-31 mu wide, 12 mu thick, wall smooth. Semicells subpyramidate, corners rounded, poles rounded-truncate or rounded, one chloroplast and one pyrenoid in each. Sinuses deep, narrow and slightly dilated at the apex. Lateral view: semicells ovate-pyriform, the whole narrowly elliptic. Vertical view: elliptic to slightly rhomboidal-elliptic. Cell wall very finely punctate.

Coll. July, 1937, Village creek, Chanute.

A number of specimens of *Cosmarium* were collected which seem to be variants of *C. granatum*. They differ from each other and from *C. granatum* in size and shape only. Descriptions of them are given below and they are figured on the plate along with *C. granatum*.

Variant 1

(Pl. X, fig. 2b)

Cells rhomboidal in outline, 27.5 mu long, 20 mu wide, 11.4 mu thick, wall smooth. Semicells angularly heart-shaped, six-sided in outline, the corners rounded, the poles rounded-truncate. Each semicell contains one chloroplast

and one pyrenoid. Sinuses deep and slightly dilated at the apices. Lateral view: semicells heart-shaped to ovate-pyriform. Vertical view: rhomboidal-elliptic.

Variant 2

(Pl. X, fig. 2c)

Cells ovoid, 19 mu long, 15 mu wide, 7.6 mu thick, wall very finely punctate, deeply constricted, sinuses narrow and slightly dilated at the apices. One axial chloroplast and one pyrenoid in each semicell. Semicells somewhat reniform with the lateral walls straight and forming an angle with the sinuses and the apical part of the semicell which is broadly rounded. Lateral view: semicells ovoid. Vertical view: elliptical.

Coll. June, 1937, Moulton's lake, Neodesha.

Cosmarium sexpapillosum sp. nov.

(Pl. X, fig. 4)

Cellula est rhomboidalis ovata; 77.9 mu longa, 57 mu lata; semicellulae paulum triangulares, polis truncatis et paribus, lateribus leviter undulatis et in polum vergentibus. Malae sunt ornatae sex magnis papillis, trinis in duobus ordinibus dispositis. Binae chlorophorae et pyrenoides sunt singulis semicellulis; sinus alti sunt et in apicibus inflati.

Cells rhomboid-ovate, 77.9 mu long, 57 mu wide, 28 mu thick, 14.5 mu wide in the isthmus. Semicells somewhat angularly three-sided, the poles truncate and even, the margins slightly crenate, cheeks ornamented with six prominent granules that are arranged in two rows of three each. Chloroplasts and pyrenoids two to each semicell. Sinuses deep and inflated at the apices.

Coll. spring, 1935, 1936, 1937, boat slough at the north end of Ohio street, Lawrence.

Cosmarium impressulum Elfv. (Taylor 1934)

(Pl. X, fig. 3)

Cells somewhat rectangular with the poles slightly inflated, 21-26 mu long, 14-18 mu wide, isthmus 4 mu wide. Semicells obscurely six-sided, margins undulate, lateral walls slightly divergent. The material collected measured 19 mu long, 15.2 mu wide, 9.5 mu thick, isthmus 5 mu wide. Sinuses deep and slightly inflated at the apices. One chloroplast and one pyrenoid in each semicell. There is a conspicuous, blunt granule in the center of each face of the semicells. Top view elliptic with a median granule on each side. Lateral view: semicells nearly orbicular to ovoid with the granule on each side median in position.

Coll. June, 1937, Moulton's lake, Neodesha.

Cosmarium Nymannianum Grün.? (Taylor 1934)

(Pl. X, fig. 5)

The Cosmarium that is being tentatively determined as *C. nymannianum* is possibly a variety. Its measurements are 37.9-39.6 mu long, 29.7 mu wide, 13.2-19.8 mu thick, and the isthmus is 10 mu wide. Semicells are broadly heart-shaped. Sinuses are deep and very slightly inflated at the apices. There is a small pore in the center of each face of a semicell which is more evident in the lateral and top views. This pore is difficult to see except in cells in

which the contents have disintegrated. In lateral view the semicells are narrowly heart-shaped to ovate. The wall is smooth, but thickened about the pore. In vertical view the semicells are elliptic with the pore evident in the thickened portion of the cell wall median in position on each side. The cells of this material are approximately half the size of *C. nymannianum*, the dimensions of which are: 52-54 mu long, 38-42 mu wide, 24-26 mu thick and 7.5-9.5 mu wide at the isthmus. There is some difference in the shape of the semicells; those of the present material have the lateral walls regularly convergent towards the pole, those of *C. nymanniamum* have the lateral walls slightly depressed. Both have the pore in the face of each semicell. This material falls well within the dimensions of *Cosmarium granatum*, but the latter species has no pores.

Coll. June, 1937, Green's pond, Lawrence.

Cosmarium humile (Gay) Nordst. var. *lacustre* Taylor, Wm. R. (Taylor 1934)

(Pl. X, fig. 6)

Cells very small, about as long as broad; semicells subrectangular to trapeziform, the basal and upper angles obliquely truncate, the sides bidentate, the upper indentation deeper; apex about six-crenate with a slight projection of the ridges, especially the submarginal ones, on to the lateral faces; isthmus linear; face of semicell usually with two low swellings above the basal angles, or these obsolete, and with strong costae, the lateral ones somewhat weaker than the central; vertical view inflated-oval, the top faintly ridged, the sides crenate because of the costae; walls thin except on the incrassate faces. Length 14-15 mu, width 15-16 mu, thickness 8.5 mu, isthmus 5 mu.

The specimens collected correspond to Taylor's description with the exceptions that the margins are more crenate than dentate, there are only four small crenations on the apex of a semicell, the costae are more distinct, being composed of a compound of three ridges, the central one of which is square when seen from above and the two outer are rounded; and, that the dimensions of the collected material are slightly greater. Length 22.8 mu, width 19 mu, thickness 11.4 mu, isthmus 7 mu.

Coll. July, 1937, Moulton's lake, Neodesha.

Cosmarium crenatum Rolfs (Hylander 1928)

(Pl. X, fig. 7)

Cells rectangular with the angles broadly rounded, 36.6 mu long, 23.9 mu wide, 14.8 mu thick, deeply constricted, sinuses narrow with apices quite dilated. Semicells subquadrate, the lateral walls parallel half way then gradually rounding into the flat pole. Polar wall very minutely crenated, lateral walls broadly crenated to undulate; faces ornamented with many small undulate inflations arranged in rows radiating from the poles. Chloroplast single, reticulate and parietal in each semicell. Lateral view: rectangular with the corners rounded, semicells rhomboidal. Vertical view: rectangular-elliptic.

Coll. June, 1937, Moulton's lake, Neodesha.

Micrasterias americana (Ehrenb.) Ralfs.

(Pl. X, fig. 8)

Cells hexagonal in outline, 132-150 mu long, 112-120 mu wide, deeply constricted, sinuses acute at the apices, opening outwards, the margins sometimes undulate and closing. Semicells five-lobed, end lobe about as wide as the combined lateral pair, expanded from the base outward, apical margins widely concave, each of the four angles formed ending in a thick divergent process with their apices truncately toothed; incisions on each side of the polar lobe are deep and open; two small papillate projections occur, one on each side of the base of the incision; lateral lobes separated by a shallow incision whose apex is rounded; each lobe divided again into two smaller lobes by an open shallow incision, each small lobe with four to seven acute teeth; chloroplast axial, five-lobed, end lobe concave or incised.

Coll. June, 1937, Chetopa creek, Altoona.

Staurastrum paradoxum Meyen

(Pl. X, fig. 9)

Semicells with three radiating arms that are annulately ringed with minute spines and which end truncately with divergent spines. Semicells contain a single chloroplast which radiates into the arms; it is axial and contains one pyrenoid.

Coll. April, 1937, Green's pond, Jackman's pond, Lawrence.

CLASS DINOPHYCEAE

SUBCLASS DINOFLAGELLATAE

Glenodinium oculatum Stein

(Pl. X, fig. 10)

Equatorial furrow completely around the cell, sulcus obscure. Chloroplasts few to many, discoid, greenish-yellow in color. The halves of the cell are approximately equal. Length 20-23 mu, width not given. The material collected measured 19-20 mu long and 15.2 mu wide.

Coll. March, 1937, boat slough at north end of Ohio street, Lawrence.

Glenodinium pulvisculus Stein

(Pl. X, fig. 11)

Cells 23 mu long, 18.4 mu wide. Cells rhomboidal in outline. Cell halves broadly bell-shaped. Walls of the equatorial furrow overhanging. Sulcus a very slight longitudinal furrow. The material collected measured 17-20 mu long and 16 mu wide.

CLASS EUGLENOPHYCEAE

FAMILY EUGLENACEAE

Euglena intermedia (Klebs) Schmitz

(Pl. X, fig. 12)

Cells linear-cylindric with a short suddenly-pointed posterior end, 120-135 mu long, 8-12.5 mu wide. Membrane delicately, spirally striated. Flagellum short. Chloroplasts numerous, discoid, without pyrenoids. Paramylum bodies

numerous throughout the cell, rectangular with smoothly rounded ends. Dividing cells secrete a gelatinous sheath about them.

Coll. 1935, 1936, 1937, year around, drainage ditch in Haskell bottoms, Green's pond, boat slough at north end of Ohio street, Lawrence.

Euglena spirogyra Ehrenb.

(Pl. X, fig. 13)

Cells weakly metabolic, lanceolate-cylindric, the forward end less attenuated than the rear, the rear end very gradually attenuated into a fine hyaline, rigid point, 80 mu long, 8 mu wide. Membrane yellow to dark brown, with spirally arranged beaded ridges, spiralling to the left. Flagellum very short. Chloroplasts numerous, discoid, dark green and without pyrenoids. Two large, thick paramylum rings lie, one before and one after the nucleus. Neucleus central in position.

Coll. March, April, 1936, June, July, 1937, drainage ditch in Haskell bottoms, Lawrence.

Euglena acus Ehrenb.

(Pl. X, fig. 14)

Cells rigid or very slightly metabolic, spindle-shaped, linear with a truncated anterior pole, the posterior end gradually attenuated into a long slender point, 140-180 mu long, 10 mu wide. Chloroplast numerous, discoid and lack pyrenoids. One to several paramylum bodies present.

Coll. 1935, 1936, 1937, April to July, Green's pond, Lawrence.

Euglena rubra Hardy

(Pl. X, fig. 15)

Cells ob-lanceolate to cylindric with a short blunt end-point at the posterior end, up to 200 mu long, 38-60 mu wide, colored a deep red-brown by haematochrome. Membrane spirally striated to the left. Flagellum about three quarters the length of the cell. Chloroplasts numerous and discoid. Paramylum grains numerous, short cylindric. Dividing cells remain for a time within the greatly enlarged cyst, aggregates of dividing cells form a scum on the water surface pseudoparenchymatous in appearance.

Coll. June, July, 1937, East Fifteenth street quarry pool, Lawrence.

Euglena truncata Walton* var. **baculifera** var. nov.

(Pl. X, fig. 16)

Cellula est cylindrata, 188-198 mu longa, 19.8-23 lata; anteriore polo acutiore, posteriore truncato. Membrana est ad sinistram forma spirae striata et a truncato polo spissata. Flagellum par est tertiae parti corporis. Nucleus ovatus in medio corporis positus est. Paramylum est simile longo et tenui baculo a tertia parte flexo. Pyrenoides desunt. Chlorophorae sunt multae et discoides.

Motile cells cylindric, 188-198 mu long, 19.8-23 mu wide, anterior end fairly pointed, posterior end truncated and slightly concave. Periplast spirally striated to the left, thickened in the truncated posterior portion. Eyespot just posterior to the conspicuous gullet; flagellum approximately one third

* Walton, 1915.

the length of the body. Nucleus oval and variable in position, being slightly anterior, central or slightly posterior. Chloroplasts numerous, discoid, slightly longer than broad. No pyrenoids. Paramylum in the form of a single long stick which may be slightly bowed but more characteristically is bent at one third of its length at about an angle of 165 degrees. It lies anterior to the nucleus when the nucleus is posterior in position; posterior to the nucleus when the nucleus is anterior in position and either above or below when the nucleus is central in position. The paramylum stick is 4-6.6 mu thick and 52.7-66 mu long. There is a large vacuole in the posterior end which becomes more evident when the organism is exhibiting euglenoid movement. While the characteristic swimming form is cylindric, the organism varies a bit and while swimming may become broadened and flattened at the posterior end or both anterior and posterior ends. When both ends are flattened it generally becomes slightly twisted to the left. The partial rigidity of the periplast of the truncated portion causes the formation of a depression at the posterior pole. In resting condition the organism becomes very broad and flattened, elliptic in outline. Those measured in this condition varied from 115.5-151.8 mu long and 37.9-42 mu in width. Encystment and division were not observed.

E. truncata var. *baculifera* is quite similar to *E. truncata* Walton (Walton, 1915) in general cell shape and in the truncated posterior end. The lengths of the two organisms are close enough to come under variability, *E. truncata* being 175 mu long, 27-29 mu wide, and var. *baculifera* being 188-198 mu long and 19.8 to 23 mu wide. However, Walton describes *E. truncata* as having the nucleus posterior in position and as having numerous small paramylum grains and no large ones. Walton also makes the statement that *E. truncata* appeared in almost all cultures taken over a period of three years, so his organism must have been fairly constant in the characters he has described for it. The present variety, though not collected over as long a period, was constant in its characters for all the collections taken in one summer. There were several accessions during the summer on account of rains, so there was good chance for any variability to appear during that season. Since the lack of small paramylum bodies and the presence of one large characteristic body has been constant for the present organism and since the truncated posterior end is so remarkably different from all other species of Euglena the author feels that the present organism should be described as a variety of *E. truncata* rather than as a distinct and new species.

Coll. summer, 1937, Village creek swamp, Chanute.

Euglena alata sp. nov.

(Pl. X, fig. 17)

Cellula est similis fasciae, 165-209 mu longa, 22.8-23 mu lata; anteriore parte rotunda, posteriore in brevem pinguem caudam spinae similem subito attenuata; toto corpore ad dextram torto. Membrana est in longitudinem striata, et elata in formam trium pinnarum a medio ad posteriorem partem pertinentium. Flagellum circiter par est tertiae parti corporis. Nucleus ovatus in medio corporis positus est. Paramylum consistit ex duobus amplis anulis, uno ante nucleum, altero post nucleum. Pyrenoides desunt. Chlorophorae sunt multae et discoides.

Motile individuals 165-209 mu long, 22.8-23 mu wide, very slightly spirally striated to almost longitudinally striated and characteristically twisted to the right. The anterior portion is flattened to form two broad faces. Along the edge of the flattened portion and opposite to the eyespot there is a groove which broadens out posteriorly so that from the middle to the posterior end there are formed three flanges with concave faces in between. The eyespot lies some distance back from the anterior end and next to the posterior end of the gullet. The flagellum is shorter than the body, approximately one third the body length. The nucleus is oval and central in position. Two long, narrow paramylum rings are present, one anterior to and the other posterior to the nucleus. No pyrenoids are present. Chloroplasts, small, numerous and discoid. The posterior end attenuates abruptly into a stout spinelike tail.

It is felt that those individuals measuring 165-189 mu in length are juvenile forms and that 209 mu is the upper limit of length, since a number of dividing individuals as well as numerous motile ones were of this length. Prior to division a motile individual comes to rest, becomes cylindrical and vacuolate and finally divides longitudinally. No gelatinous sheath or division cyst is formed.

The two described species nearest to *Euglena alata* are *E. oxyuris* and *E. tripteris*. *E. oxyuris* is 375-490 mu long, 30-45 mu wide and is figured as cylindrical in shape. *E. tripteris* is 70-80 mu long, 8-14 mu wide and is figured as twisted and flanged in shape. *Euglena alata* falls well above the greatest length of *E. tripteris* and well below the shortest length of *E. oxyuris*.

Coll. June, July, 1937, drainage ditch in Haskell bottoms, Lawrence; Village creek swamp, Chanute; Chetopa creek, Altoona.

Euglena fusca (Klebs) Lemm

(Pl. X, fig. 21)

Cells weakly metabolic, elongate and flattened, posterior gradually attenuated and ending in a short stout tail, 90 to 225 mu long, 23-27.5 mu wide. Periplast dark brown to black, longitudinally striated. Flagellum as long as the body. Chloroplasts discoid, numerous. Pyrenoids lacking. Two large, thick paramylum rings are present, one on each side of the nucleus. Dividing and resting cells without a gelatinous sheath.

Coll. June, July, 1937, drainage ditch in Haskell bottoms, East Fifteenth street ditch, Lawrence.

Euglena tripteris (Duj.) Klebs

(Pl. X, fig. 23)

Cells slightly metabolic, long band-shaped, spirally twisted, with a long, slender, sharp tail, 70-80 mu long, 8-14 mu wide. Periplast longitudinally striated. Flagellum one half the body length. Chloroplasts numerous, discoid. Pyrenoids lacking. There are two long sticklike paramylum bodies, one before the one back of the nucleus. Division stage sheathless.

Coll. June, July, 1937, Green's pond, Lawrence; June, Chetopa creek pool, Altoona.

Euglena torta Stokes

(Pl. X, fig. 24)

Cells rigid, spindle-shaped, spirally twisted to the left, with a sharp tail, 63 mu long, 13 mu wide. Membrane smooth, flagellum almost body length.

Chloroplasts numerous, discoid. Pyrenoid? There are two long sticklike paramylum bodies, one before and one behind the nucleus. Division and resting stages not known.

Coll. July, 1937, Green's pond, Lawrence.

Euglena acutissima Lemm.

(Pl. X, fig. 28)

Cells rigid, linear-spindle-shaped, attenuated into a long sharp tail, 123 mu long, 7 mu wide. Periplast weakly, spirally striated. Flagellum short. Chloroplasts numerous, discoid, in spiral lines. Pyrenoids lacking. Two paramylum bodies are present, one before the other, behind the nucleus. Division and resting stages not known.

Coll. May, June, 1937, Green's pond, boat slough at north end of Ohio street, Lawrence.

Euglena deses Ehrenb.

(Pl. X, fig. 18)

Cells very metabolic, long-cylindric or ribbonlike, with a very short tail, 80-90 mu long, 15-22 mu wide. Periplast weakly spirally striated to the left. Flagellum short, chloroplasts numerous, discoid. Pyrenoids naked. Paramylum bodies rodlike. Dividing cells within a gelatinous sheath.

Coll. July, 1937, drainage ditch in Haskell bottoms, Lawrence.

Euglena flava Dang.

(Pl. X, fig. 29)

Cells metabolic, spindle-shaped, with a short tail, 60 mu long, 25-30 mu wide, colored red by the presence of haematochrome. Periplast smooth. Flagellum body length. Chloroplasts 3-15, discoid. Pyrenoids doubly sheathed. Paramylum? Dividing cell within a thin sheath.

Coll. July, 1937, Green's pond, drainage ditch in Haskell bottoms, Lawrence.

Euglena variabilis Klebs.

(Pl. X, fig. 27)

Cells very lively-metabolic, short-cylindric with a short, blunt tail or almost egg-shaped. Periplast strongly, spirally striated, 30.5-46 mu long, 9-13 mu wide. Flagellum two to three times the body length. Chloroplasts numerous, discoid. Pyrenoids lacking. Eyespot very large, dark red. There is one large paramylum body near the gullet. Dividing cells egg-shaped, without a sheath.

Coll. July, 1937, boat slough at north end of Ohio street, drainage ditch in Haskell bottoms, Lawrence.

Euglena geniculata Duj.

(Pl. X, fig. 22)

Cells lively-metabolic, long-cylindric, posterior portion attenuated into a short tail, 70-85 mu long, 12-22 mu wide. Periplast delicately spirally striated. Flagellum almost body length. Chloroplasts star-shaped, one before and one behind the nucleus. Pyrenoids covered with a sheath of small paramylum bodies. Dividing cells within a thin sheath.

Coll. July, 1937, Chetopa creek pool, Altoona.

Euglena spiroides Lemm.

(Pl. X, fig. 19)

Cells little metabolic, elongate-cylindric to ribbon-shaped, spirally twisted, with a short tail, 60-170 mu long, 16 mu wide. Periplast delicately longitudinally striated. Flagellum short. Chloroplasts numerous, discoid. Pyrenoids lacking. Paramylum bodies small, round. Division and resting stages not known.

Coll. May, 1936; July, 1937, Green's pond, boat slough at north end of Ohio street, Lawrence.

Euglena Grisoli Deflandre (Pascher 1929)

(Pl. X, fig. 20)

Cells weakly metabolic, long-cylindric, suddenly constricted at the posterior end into a short tail, 68-75 mu long, 10-13 mu wide, spirally twisted or curved to the left. Periplast spirally striated to the left with embossed, elongated, bacteria-like verrucae. Chloroplasts numerous discoid. Two large sticklike paramylum bodies are present, one above and one below the nucleus. Pyrenoids lacking. Flagellum approximately half the body length.

Coll. June, July, 1937, Green's pond, Lawrence.

Euglena viridis Ehrenb.

(Pl. X, fig. 25)

Cells lively-metabolic, spindle-shaped with a short tail, 52-57 mu long, 14-18 mu wide. Periplast delicately spirally striated. Flagellum body length. Chloroplast star-shaped, in front of the nucleus. Pyrenoids sheathed with small paramylum grains. Dividing cells within a gelatinous sheath. Resting cells within a thick, layered cyst membrane.

Coll. July, 1937, Green's pond, Lawrence.

Euglena proxima Dang.

(Pl. X, fig. 26)

Cells lively-metabolic, spindle-shaped with a colorless tail, 60-70 mu long, 20 mu wide. Periplast spirally striated to the left. Flagellum one to one and one half times the body length. Chloroplasts numerous, discoid. Pyrenoids lacking. Paramylum bodies ring-shaped or short-cylindric. Dividing cells with a thin sheath. Resting cells with a thicker, layered membrane.

Coll. June, July, 1937, Green's pond, drainage ditch in Haskell bottoms Lawrence.

Lepocinclis Steinii Lemm.

(Pl. XI, fig. 6)

Cells short-spindle-shaped, 22-30 mu long, 8-15 mu wide. Posterior attenuated into a tail 1.5-4 mu long. Periplast striated scarcely spirally almost longitudinally. Two large paramylum rings present, one on each side of the middle.

Coll. May, June, July, 1937. Green's pond, boat slough at north end of Ohio street, Lawrence.

Lepocinclis Butschlii Lemm. var. *angustata* Deflandre (Pascher 1929)

(Pl. XI, fig. 4)

Cells broad and plump, spindle-shaped to rhomboidal, 32-42 mu long, 13-16 mu wide. Periplast spirally striated to the left.

Coll. June, July, 1937, boat slough at north end of Ohio street, Lawrence.

Lepocinclis ovum (Ehrenb.) Lemm.

(Pl. XI, fig. 1)

Cells oval, 30-38 mu long, 15-18 mu wide. Posterior end sharply attenuated into a tail 6-7 mu long. Flagellum twice the body length. Periplast strongly spirally striated to the left.

Coll. spring, July, 1937, boat slough at north end of Ohio street, Lawrence; June, Chetopa creek pool, Altoona.

Lepocinclis ovum (Ehrenb.) Lemm. var. *globula* (Perty) Lemm.

(Pl. XI, fig. 2)

Cells almost orbicular, 20-27 mu long, 16-21 mu wide. Flagellum 2-3 times the body length.

Coll. July, 1937, Green's pond, Lawrence.

Lepocinclis ovum (Ehrenb.) Lemm. var. *palatina* Lemm.

(Pl. XI, fig. 3)

Cells egg-shaped, 20 mu long, 15.5 mu wide. Periplast spirally striated to the left with short striae.

Coll. July, 1937, stock pool in the sand hills, Burrton.

Lepocinclis acicularis France

(Pl. XI, fig. 5)

Cells long and small spindle-shaped, 21-22 mu long, 6-9 mu wide. Flagellum over body length. Periplast spirally striate to the left with, at the most, 12 striae.

Coll. July, 1937, field ditch, Neodesha.

Lepocinclis fusiformis (Carter) Lemm.

(Pl. XI, fig. 8)

Cells short and broad spindle-shaped or lemon-shaped, 25 to 51 mu long, 12-49 mu wide. Periplast delicately spirally striated to the left. Flagellum 1-1½ times the body length. Anterior pole is a short snout which is divided into two lips or papillae between which the flagellum is inserted.

Coll. July, 1937, boat slough at north end of Ohio street, Lawrence.

Lepocinclis turbiniformis Deflandre (Conrad 1934)

(Pl. XI, fig. 7)

Cells turbinate, the anterior portion nearly spherical, attenuated rapidly to a base from which there projects a short, pointed tail. Periplast spirally striated to the left. Flagellum 1½-2 times the body length. Chloroplasts

numerous, discoid. Length 33 mu, width 22 mu. The material collected agrees well with the description of *L. turbiniformis* up to the description of the tail. The tail of the individuals collected in Kansas is 9.9 mu long and blunt at the apex, not just a sharp spine-like projection as figured and described by Deflandre. The eyespot is at the anterior end nearly median in position and slightly below the depression in which the flagellum is inserted.

Coll. April, May, June, July, 1937, boat slough at north end of Ohio street, Lawrence; June, Chetopa creek, Altoona.

Lepocinclis texta (Duj.) Lemm.

(Pl. XI, fig. 9)

Cells broadly oval, 52-60 mu long, 38 mu wide. Periplast strongly spirally striated to the right. Flagellum 2-3 times the body length. Paramylum grains numerous, cylindric or ring-shaped. Chloroplasts numerous, discoid. The individuals collected measured 49.5-51 mu long, 39.6-42.9 mu wide.

Coll. June, July, 1937, Green's pond, Lawrence; June, Chetopa creek pool, Altoona.

Lepocinclis truncata Da Cunha (Conrad 1934)

(Pl. XI, fig. 10)

Cells broadly ovoid to rhomboid with the anterior pole truncated and flat and the posterior pole round-pointed, 40 mu long, 28 mu wide. The material collected measured 46 mu long, 33 mu wide. Periplast delicately spirally striated to the left. Chloroplasts numerous, discoid. Flagellum 1-1½ times body length. Two large thick paramylum rings are present.

Coll. June, 1937, Chetopa creek pool, Altoona.

Phacus longicauda (Ehrenb.) Duj.

(Pl. XI, fig. 11)

Cells oval with a long attenuated tail, 85-144.4 mu long, 46-70 mu wide. Periplast longitudinally striated. Flagellum shorter than the body length. There is one large disk-shaped or ring-shaped paramylum body in each cell.

Coll. April, May, June, July, 1937, boat slough at north end of Ohio street, Green's pond, Lawrence; Chetopa creek pool, Altoona.

Phacus longicauda (Ehrenb.) Duj. var. *torta* Lemm.

(Pl. XI, fig. 12)

Similar to *P. longicauda* in all respects except that the individuals are strongly twisted, like a propeller.

Coll. spring, 1937, boat slough at north end of Ohio street, Lawrence.

Phacus anacoelus Stokes

(Pl. XI, fig. 13)

Cells oval or roundish, inflated into five flanges with concave sides, 42.9 mu long, 39.6 mu wide. Periplast longitudinally striated. Tail short. Flagellum body length. 1-2 paramylum rings may be present.

Coll. July, 1937, Green's pond, Lawrence; Village creek, Chanute.

Phacus acuminata Stokes

(Pl. XI, fig. 14)

Cells broadly egg-shaped or almost circular, 21-25 mu long, 14-25 mu wide. Posterior end suddenly pointed. Periplast longitudinally striated. Median fold on the dorsal surface comblike, nearly reaching the posterior end. Flagellum body length. Two small round paramylum bodies are present.

Coll. April-July, 1937, boat slough at north end of Ohio street, Lawrence. Other individuals seen in culture are illustrated in figure 20, plate XI. Their dimensions lie near those of *P. acuminata*, they are of the same shape, varying a little, and show no prominent ridge along the dorsal surface. However, from the fact that they were all seen in the same culture as *P. acuminata* and that they so nearly approximate *P. acuminata* in size and appearance, it is felt that they are possible variants. The paramylum bodies vary in number and size. The three individuals were chosen to figure as representative of the three degrees of variation that occurred in the culture. All forms were numerous, including those that exactly fit the description of *P. acuminata.*

Figure 20 (a) 19.8 mu long, 9.9 mu wide.
Figure 20 (b) 22.8 mu long, 19 mu wide.
Figure 20 (c) 19.8 mu long, 13.2 mu wide.

Phacus pusilla Lemm.

(Pl. XI, fig. 15)

Cells long-oval, 20 mu long, 7.5 mu wide, both sides with winglike inflations. Anterior end concave, posterior end short pointed to almost round. Periplast spirally striated. Flagellum one half body length. Two ringlike paramylum bodies may be present.

Coll. July, 1937, stock pool in the sand hills, Burrton.

Phacus caudata Hubner

(Pl. XI, fig. 16)

Cells long-oval, 45 mu long, 22.5 mu wide. Tail short, dorsal fold reaching to the posterior end. Periplast longitudinally striated. Flagellum body length. One large paramylum ring before the nucleus, a smaller one behind near the tail.

Coll. May, 1937, boat slough at north end of Ohio street, Lawrence.

Phacus pyrum (Ehrenb.) Stein

(Pl. XI, fig. 17)

Cells ovoid, posterior portion attenuated gradually into a long tail, 30-55 mu long, 13-15 mu wide. Periplast spirally striated to the left, striae very strong. Flagellum body length. Two large or more smaller paramylum bodies, disk-shaped, lie to the sides. Few large discoid chloroplasts are present.

Coll. April-July, 1937, boat slough at north end of Ohio street, Lawrence; June, Village creek swamp, Chanute.

Phacus triqueter (Ehrenb.) Duj.

(Pl. XI, fig. 18)

Cells oval, 49-55 mu long, 33-35 mu wide. Tail short, sharp. Dorsal fold comblike, reaching the posterior end. Periplast longitudinally striated. Flagellum body length. One to two paramylum rings may be present.

Coll. June-July, 1937, Green's pond, Lawrence.

Phacus hispidula (Eichw.) Lemm.

(Pl. XI, fig. 19)

Cells oval, with a short tubular flagellum opening and a short, blunt tail, 30-35 mu long, 18-33 mu wide. Periplast longitudinally striated. Striae finely toothed with small spines. Flagellum body length. Paramylum bodies stick-like to discoid.

Coll. July, 1937, Green's pond, Lawrence.

Phacus inflata sp. nov.

(Pl. XI, fig. 21)

Cellula fere quadrata est, ex posteriore parte brevissima et obtuse gibbosa; 42.2 mu longa, 42.2 mu lata; membranum non manifesto striatum est; flagellum par est longitudini corporis; chlorophorae multae et discoides sunt.

Cells almost quadratic or obscurely five-sided with a very short, blunt posterior protuberance, 42.2 mu long, 42.2 mu wide, 14 mu thick., Periplast not striated. Flagellum body length. Chloroplasts numerous and discoid.

Coll. June, 1937, Village creek, Chanute.

Crypotoglena pigra Ehrenb.

(Pl. XII, fig. 2)

Cells ovate and somewhat compressed. Anterior pole broadly rounded, posterior pole acute. Two laminate, longitudinal chloroplasts, one on each side of the cell. Cells 11-15 mu long, 6-9.5 mu wide. Flagellum body length.

Coll. March-April, 1937, Jackman's pond, Green's pond, boat slough at north end of Ohio street, Lawrence.

Trachelomonas oblonga Lemm.

(Pl. XII, fig. 3)

Lorica oval, 13-16 mu long, 11-12 mu wide, with or without a short collar. Flagellum opening circular. Lorica yellow-brown to deep red-brown, sometimes covered with irregular deposits of iron compounds.

Coll. March-July, 1937, boat slough at north end of Ohio street, Green's pond, Lawrence; July, stock pool in sand hills, Burrton.

Trachelomonas volvocina Ehrenb.

(Pl. XII, fig. 1)

Lorica spherical to slightly ovoid, 7-21 mu in diameter, light to deep yellow-brown, smooth. Flagellum opening circular, seldom with a collar. Flagellum 2-3 times the length of the lorica.

Coll. March-July, 1937, Green's pond, Lawrence; April, June, Village creek swamp, Chanute.

Trachelomonas volvocina Ehrenb. var. *cervicula* (Stokes) Lemm.

(Pl. XII, fig. 4)

Lorica spherical, 23 mu in diameter, smooth, yellow-brown. Flagellum opening circular with a tubular collar that projects inward as well as exteriorly. Chloroplasts numerous and discoid. Flagellum 2-3 times diameter of the lorica.

Coll. July, 1937, Village creek swamp, Chanute.

Trachelomonas hispida (Perty) Stein var. *cylindrica* Klebs

(Pl. XII, fig. 5)

Lorica cylindrical, thickly ornamented with very fine spinelike granules, 23-26.4 mu long, 14.8-16.5 mu wide. Flagellum opening collared with a toothed crown. Flagellum 2-3 times lorica length.

Coll. July, 1937, stock pool in the sand hills, Burrton.

Trachelomonas hispida (Perty) Stein

(Pl. XII, fig. 6)

Lorica oval, thickly ornamented with very fine spines, 20 to 42 mu long, 15-26 mu wide. Flagellum opening with a short collar which may be toothed and may be lacking. Chloroplasts 8-10, each with a double-layered pyrenoid. Flagellum 1½-2 times body length.

Coll. July, 1937, stock pool in the sand hills, Burrton; boat slough at north end of Ohio street, Lawrence.

Trachelomonas Vermonti Deflandre (Pascher 1929)

(Pl. XII, fig. 9)

Lorica in cross section four-sided, the angles rounded and the sides inflated slightly. Lorica from one side cylindrical to broadly ovoid, at the base ending in a blunt, short point, smooth or lightly granular. Chloroplasts 8-12, parietal, discoid and without pyrenoids. Flagellum 1½ times length of the lorica.

Coll. July, 1937, stock pool in the sand hills, Burrton.

Tranchelomonas armata (Ehrenb.) Stein

(Pl. XII, fig. 7)

Lorica broadly oval, not punctate, ornamented at the posterior end with a circle of long spines, 29-64 mu long, 31.3 mu wide. Flagellum opening thickened or with a toothed collar. Flagellum twice the length of the lorica.

Coll. June, July, 1937, Green's pond, boat slough swamp at north end of Ohio street, Lawrence.

Trachelomonas pulchra var. elongata Swirenko (Pascher 1929)

(Pl. XII, fig. 8)

Lorica broadly ellipsoidal, brown, 35-39 mu long, 26-30 mu wide. Anterior and posterior poles ornamented with seemingly irregularly placed, short, dull spines. Chloroplasts numerous, discoid, up to 8 mu wide, without pyrenoids. Flagellum three times the length of the lorica.

Coll. July, 1937, Green's pond, boat slough swamp at north end of Ohio street, Lawrence.

CHAROPHYTA

FAMILY CHARACEAE

SUBFAMILY NITELLEAE

Nitella opaca Ag.

(Pl. XII, fig. 10)

Plant body becomes a large, widespreading bush in quiet water. It is dioecious, not encrusted with calcium and there is no gelatinous sheath around the sex organs. The leaves are but once divided and the end segment is one-celled. The corona on the oögonium is deciduous. It is made up of five two-celled tips. The tips of the five spirally wound oögonial sheath cells spread after the shedding of the corona. The oögonia may be one to three at a node. The antheridia are always single at a node. The zygote with 6-7 spiral flanges is 300-360 mu long, and almost as broad. The antheridium is 464-496 mu in diameter.

Coll. April, 1937, small creek pool ½ mile west of town, Altamont.

SUBFAMILY CHAREAE

Chara foetida A. Br.

(Pl. XII, fig. 11)

Plant entirely encrusted except for the subulate tips of the leaves, monoecious, the oögonia and antheridia being borne at the same node with the oögonia above the antheridia. Leaves 6-11 in a whirl at a node, 8 in a whirl in the material collected. Stipules in two rows or series. Internodal cells twice as many as there are leaves in the node above. Node cells or the blunt protuberances at the nodes of the internodal cells occur in the furrows between the overhanging internodal cells on each side. The leaflets at a node on the opposite side to the sex organs almost entirely undeveloped, scarcely longer than broad. Antheridia 250-300 mu in diameter. Oögonia 750-800 mu long, 450 to 500 mu wide, with 12-15 spirals.

Coll. April, 1935, Deer creek, Garnett; June, 1937, Lost canyon side hill swamp and spring, Neodesha.

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PLATE I

1. *Chroococcus turgidus.* $\times$ 166.
2. *Chroococcus caldariorum.* $\times$ 166.
3. *Chroococcus limneticus.* $\times$ 166.
4. *Gleocapsa magma.* $\times$ 166.
5. *Gleocapsa mellea.* $\times$ 166.
6. *Gleocapsa aeruginosa.* $\times$ 166.
7. *Microcystis marginata.* $\times$ 166.
8. *Merismopedia punctata.* $\times$ 333.
9. *Merismopedia elegans.* $\times$ 333.
10. *Merismopedia elegans?* (See text.) $\times$ 125.
11. *Eucapsis alpina.* $\times$ 333.
12. *Aphanothece microscopica.*
    (*a*) Colony. $\times$ 83.
    (*b*) Single cell. $\times$ 333.
13. *Pleurocapsa minor.* $\times$ 166.
14. *Merismopedia angularis* sp. nov. $\times$ 210.
    (*b*) Side view.
15. *Chamaesiphon cylindricus.* $\times$ 666.
16. *Oscillatroroia curviceps.* $\times$ 333.
17. *Chamaesiphon gracilis.* $\times$ 666.
18. *Oscillatoria sancta.* $\times$ 166.
19. *Oscillatoria simplicissima.* $\times$ 333.
20. *Spirulina major.* $\times$ 333.
21. *Oscillatoria guttulata.* $\times$ 333.
22. *Oscillatoria jenensis.* $\times$ 166.
23. *Arthrospira jenneri.* $\times$ 333.
24. *Phormidium tenue.* $\times$ 333.
25. *Lyngbya Birgei.* $\times$ 166.
26. *Microcoleus vaginatus.* $\times$ 333.
27. *Lyngbya aerugineo-caerulea.*
    (*a*) Spore formation. $\times$ 333.
    (*b*) Vegetative filament. $\times$ 333.

PLATE I

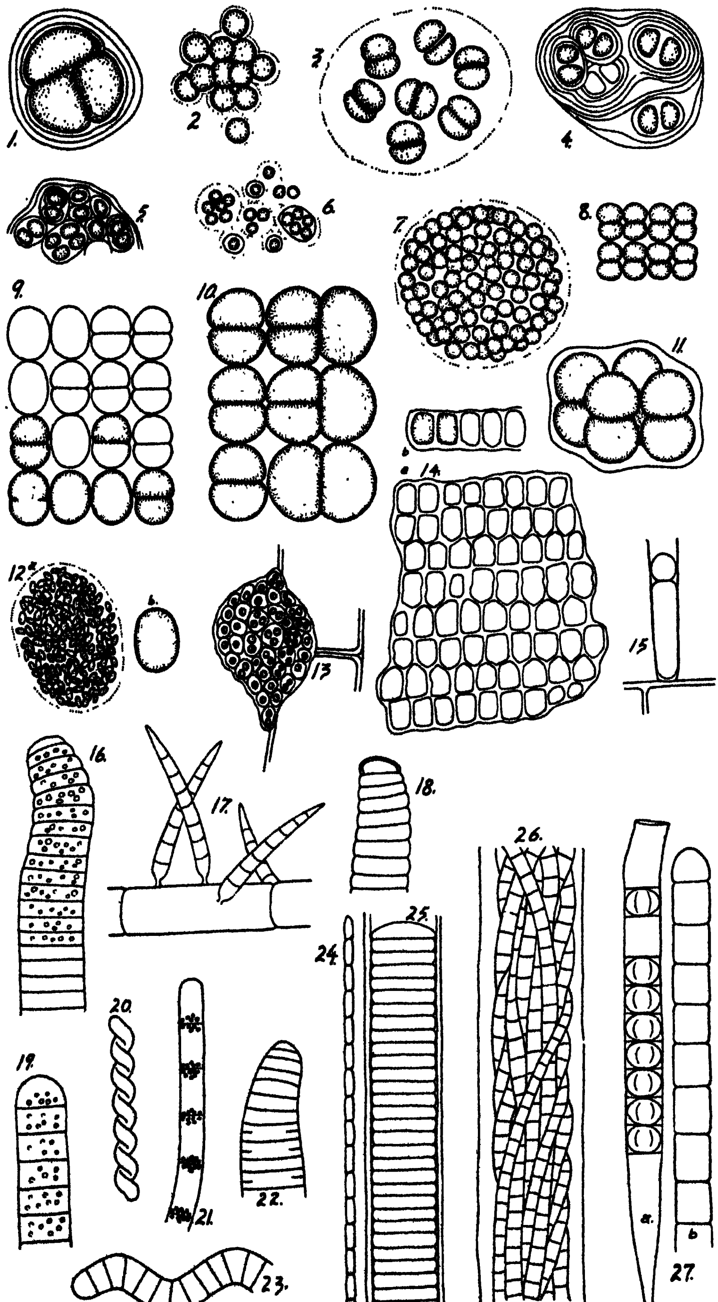
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PLATE II

1. *Nostoc verrucosum.*
   (*a*) Colony. × 333.
   (*b*) Single filament. × 333.
2. *Nostoc fuscescens* var. *mixta.* × 333.
3. *Nostoc coeruleum.* × 333.
4. *Anabaena californica.* × 333.
5. *Nostoc muscorum.* × 333.
6. *Cylindrospermum maius.* × 333.
7. *Cylindrospermum minutissimum.* × 333.
8. *Rivularia planctonica.* × 333.
9. *Calothrix Braunii.* × 333.
10. *Rivularia compacta.* × 333.
11. *Plectonema Golenkiniana.* × 666.
12. *Scytonema myochrous.* × 333.
13. *Porphyridium cruentum.*
    (*a*) Cells. × 166.
    (*b*) After Lewis and Zirkle, 1920. × 200.
14. *Botrydium granulatum.*
    (*a*) Vegetative thallus. × 16.6.
    (*b*) Thallus breaking up into hypnospores. × 16.6.
    (*c*) Variously shaped hypnospores. × 63.
15. *Synura uvella.*
    (*a*) Mature colony. × 166.
    (*b*) Small young colony. × 166.
    (*c*) Single individual. × 333.
16. *Mallomonas tonsurata.* × 333.
17. *Chromulina ovalis.* × 333.
18. *Cryptomonas ovata.* × 170.
19. *Tribonema bombycinum.* × 166.
20. *Phaeothamnion Borzianum.*
    Palmella stage. × 166.

PLATE II

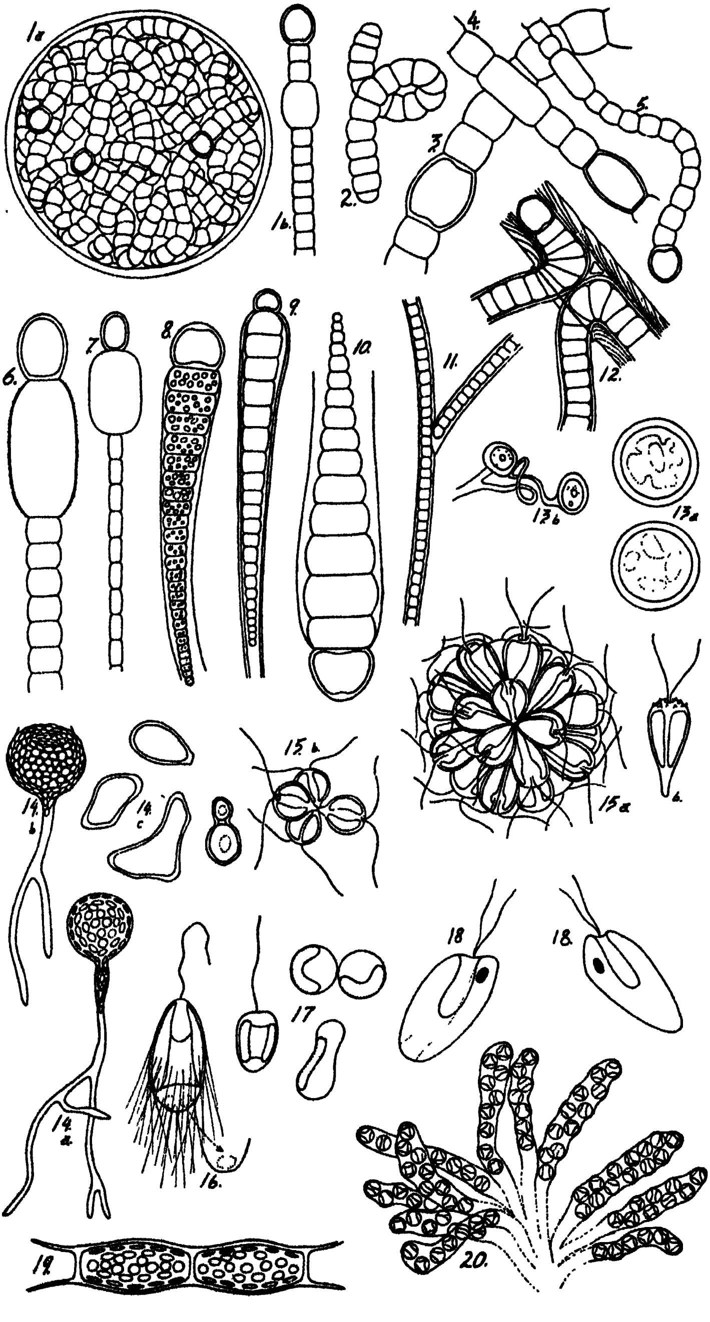
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PLATE III

1. *Chlamydomonas intermedia.*
   (*a*) Motile individual. × 333.
   (*b*) Palmella stage. × 333.
2. *Chlorogonium enchlorum.*
   (*a*) Adult. × 333.
   (*b*) Zoöspore production. × 333.
   (*c*) Zoöspores escaping. × 333.
3. *Chlorogonium spirale.* × 333.
4. *Wislouchiella planctonica.*
   (*a*) Front view. × 250.
   (*b*) Side view. × 250.
   (*c*) Top view. × 250.
5. *Carteria cordiformis.* × 250.
6. *Chlamydomonas variabilis.* × 333.
7. *Phacotus lenticularis.*
   (*a*) Front and side views. × 333.
   (*b*) Palmella stage. × 333.
   (*c*) Zoöspore production. × 333.
8. *Gonium sociale.*
   (*a*) Top view. × 166.
   (*b*) See text. × 166.
9. *Gonium formosum.* × 166.
10. *Pandorina morum.*
    (*a*) Vegetative colony. × 166.
    (*b*) Sexual colony. × 166.
11. *Eudorina elegans.* × 166.

PLATE III

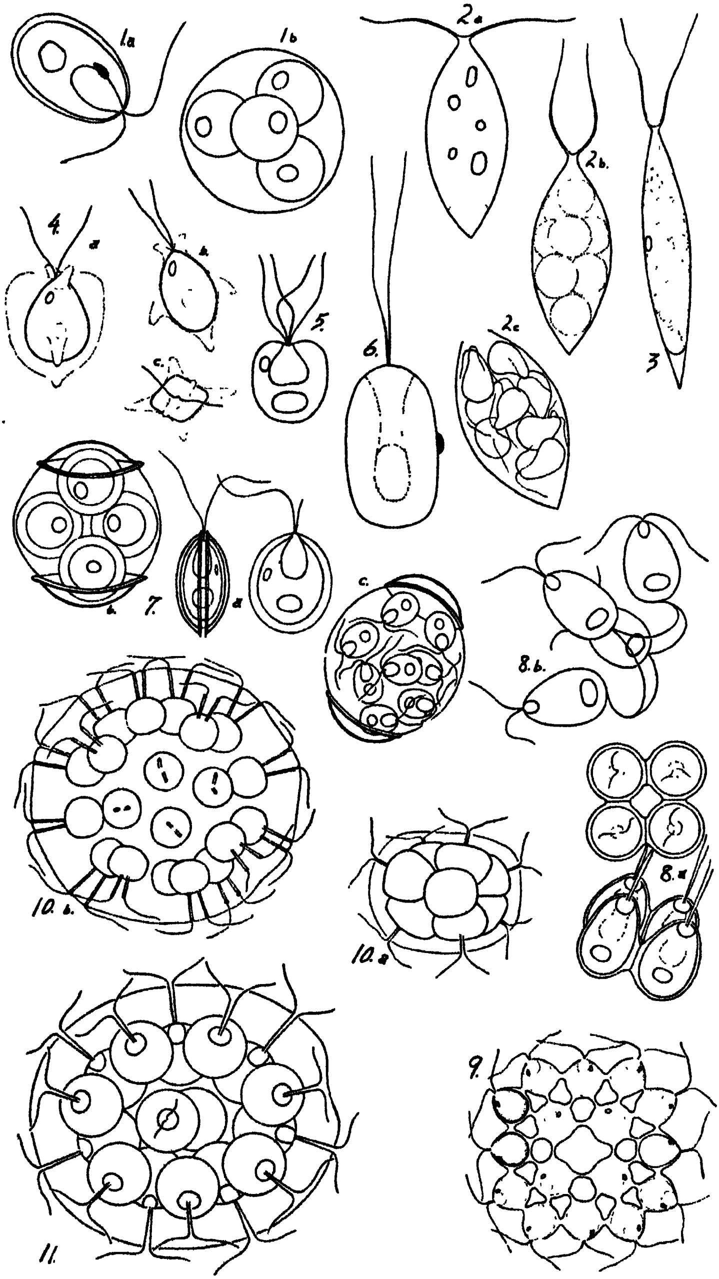


PLATE IV

1. *Spondylomorum quaternarium.* × 292.
2. *Sphaerella lacustris.* × 166.
   (*a*) Motile individual.
   (*b*) Akinete.
   (*c*) Microgamete.
   (*d*) Aplanospore.
   (*e*) Akinete germinating by zoöspores.
3. *Tetraspora gelatinosa.* × 250.
4. *Ourococcus bicaudatus.* × 333.
5. *Tetraspora cylindrica.* × 250.
6. *Coccomyxa dispar.* × 333.
7. *Nannochloris bacillaris.* × 333.
8. *Chlorosarcina consociata.* × 166.
9. *Ulothrix tenuissima.* × 166.
10. *Gleotila protogenita.* × 166.
11. *Hormidium flaccidum.* × 166.
12. *Stichococcus subtilis.* × 166.
13. *Microspora tumidula.* × 166.
14. *Microsporq stagnorum.* × 166.
15. *Geminella ordinata.* × 166.
16. *Cylindrocapsa geminella.* × 166.
17. *Chaetovhora elegans.* × 166.
18. *Draparnaldia Ravenelii.* × 16.6.
19. *Chaetophora incrassata.* × 166.
20. *Draparnaldia plumosa.* × 16.6.

PLATE IV

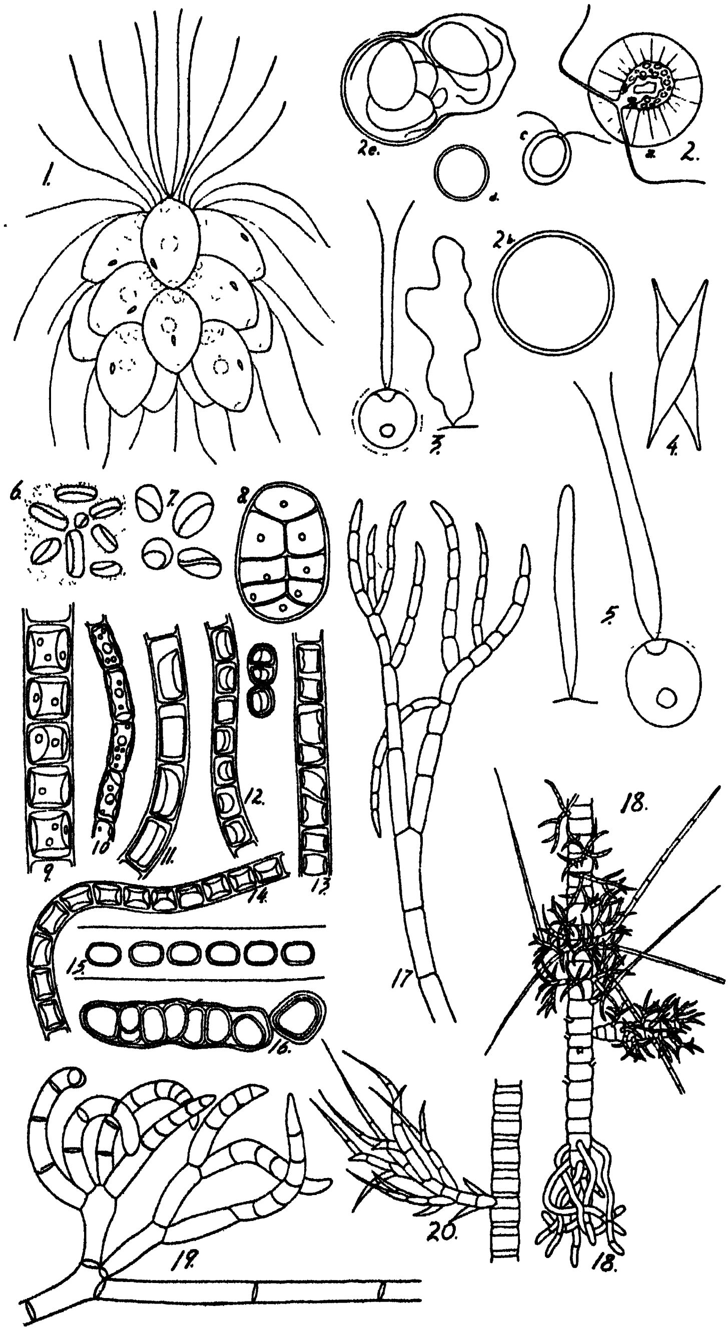


PLATE V

1. *Microthamnion Kuetzingianum.* × 166.
2. *Aphanochaete repens.* × 83.
3. *Ulvella involvens.* × 166.
4. *Coleochaete scutata.* × 33.
5. *Rhizoclonium crispum.* × 16.6.
6. *Chaetopeltis orbicularis.* × 8.
7. *Cladophora glomerata.* × 33.
8. *Pithophora kewensis.* × 20.
9. *Basicladia chelonum.* × 41.
10. *Oedogonium globosum.* × 166.
11. *Oedogonium crispum.* × 166.

PLATE V

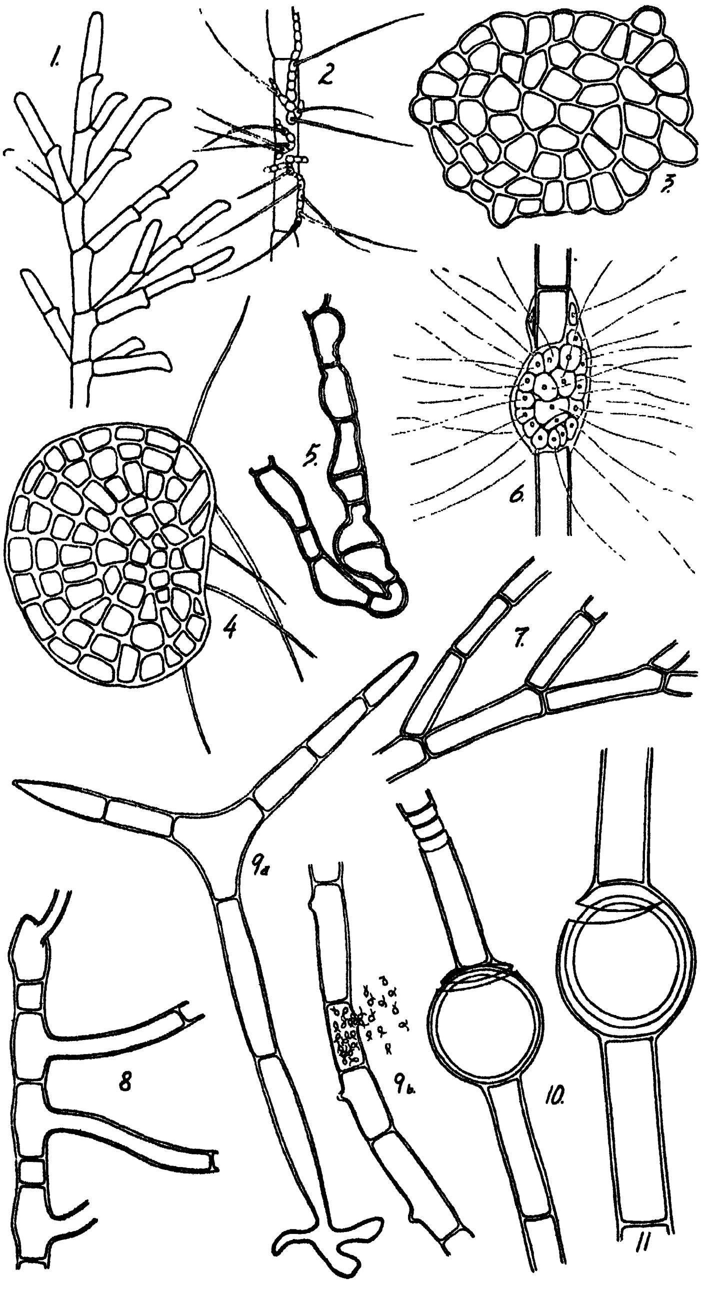


PLATE VI

1. *Oedogonium cyathigerum.* × 83.
2. *Bulbochaete varians.* × 83.
3. *Schizomeris Leibleinii.* × 41.
   (*a*) Portions at intervals of a thallus.
   (*b*) (*c*) Terminal and intercalary zoösporangia.
   (*d*) Different apical cells.
4. *Chlorococcum humicola.* × 333.
5. *Chlorococcum infusionum.* × 333.
6. *Schizogonium murale.* × 166.
7. *Chlorochytrium lemnae.* × 93.
8. *Golenkinia radiata.* × 166.
9. *Characium ornithocephalum.* × 750.
10. *Characium angustum.* × 750.
11. *Characium Naegelii.* × 750.
12. *Characium Braunii.* × 750.
13. *Pediastrum Boryanum.*
    (*a*) Typical coenobium. × 125.
    (*b*) Four-celled coenobium. × 166.
14. *Pediastrum Boryanum* var. *brevicorne.* × 166.
15. *Pediastrum duplex* var. *cornutum.* × 83.
16. *Pediastrum duplex* var. *reticulatum.* × 166.
17. *Pediastrum tetras.* × 166.
18. *Pediastrum duplex* var. *gracillimum.* × 125.
19. *Pediastrum Boryanum* var. *longicorne.* × 166.

PLATE VI

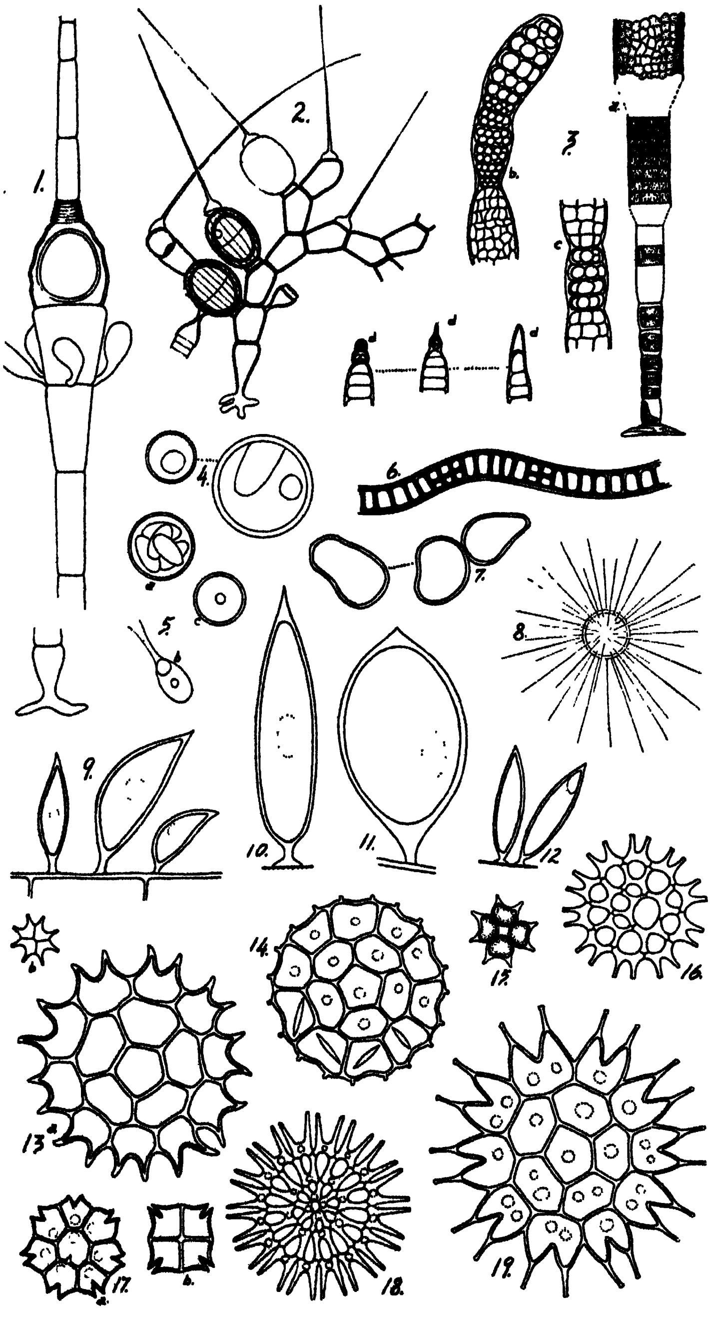


PLATE VII

1. *Pediastrum duplex* var. *clathratum*. $\times$ 83.
2. *Pediastrum clathratum*. $\times$ 333.
3. *Pediastrum simplex* var. *radians*. $\times$ 125.
4. *Pediastrum clathratum* var. *duodenarium*. $\times$ 166
5. *Coelastrum sphaericum*. $\times$ 166.
6. *Coelastrum microporum*. $\times$ 166.
7. *Coelastrum reticulatum*. $\times$ 166.
8. *Chlorella conductrix*.
   (*a*) Single cell. $\times$ 333.
   (*b*) Habit. $\times$ 83.
9. *Westella botryoides*. $\times$ 166.
10. *Dictyosphaerium pulchellum*. $\times$ 333.
11. *Trochiscia pachyderma*. $\times$ 166.
12. *Excentrosphaera viridis*. $\times$ 166.
13. *Schroederia setigera*. $\times$ 333.
14. *Oöcystis parva*. $\times$ 333.
15. *Oöcystis elliptica*. $\times$ 103.
16. *Dimorphococcus lunatus*. $\times$ 333.
17. *Closteridium lunula?* $\times$ 333.
18. *Ankistrodesmus falcatus* var. *mirabile*. $\times$ 333.
19. *Ankistrodesmus falcatus* var. *acicularis*. $\times$ 333.

PLATE VII

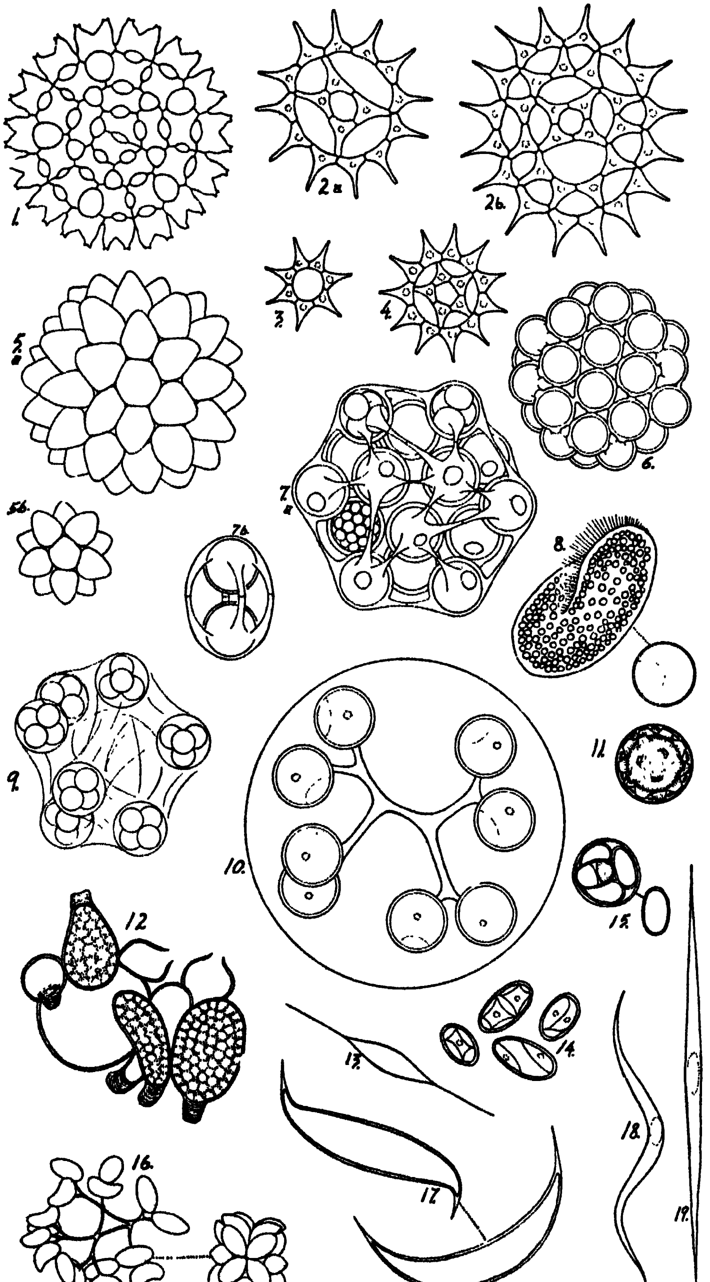


PLATE VIII

1. *Selenastrum gracile.* × 166.
2. *Kirchneriella contorta.* × 333.
3. *Kirchneriella lunaris.* × 333.
4. *Tetraëdron caudatum.* × 250.
5. *Tetraëdron minimum.* × 250.
6. *Tetraëdron punctulatum.* × 250.
7. *Tetraëdron trilobatum.* × 166.
8. *Tetraëdron pentaëdricum.* × 166.
9. *Tetraëdron trigonum* var. *minor.* × 166.
10. *Tetraëdron tumidulum.* × 166.
11. *Tetraëdron proteiforme.* × 83.
12. *Scenedesmus obliquus.* × 333.
13. *Scenedesmus dimorphus.* × 333.
14. *Scenedesmus bijuga.* × 333.
15. *Scenedesmus quadricauda.* × 333.
16. *Scenedesmus abundans.* × 333.
17. *Crucigenia rectangularis.* × 333.
18. *Scenedesmus denticulatus.* × 308.
19. *Actinastrum gracillimum.* × 375.
20. *Actinastrum Hantzschii* var. *javanicum.* × 375.
21. *Tetrastrum apiculatum.* × 333.
22. *Tetrastrum elegans.* × 333.
23. *Crucigenia tetrapedia.* × 333.
24. *Micractinium pusillum.* × 250.
25. *Errerella bornhemiensis.* × 250.

PLATE VIII

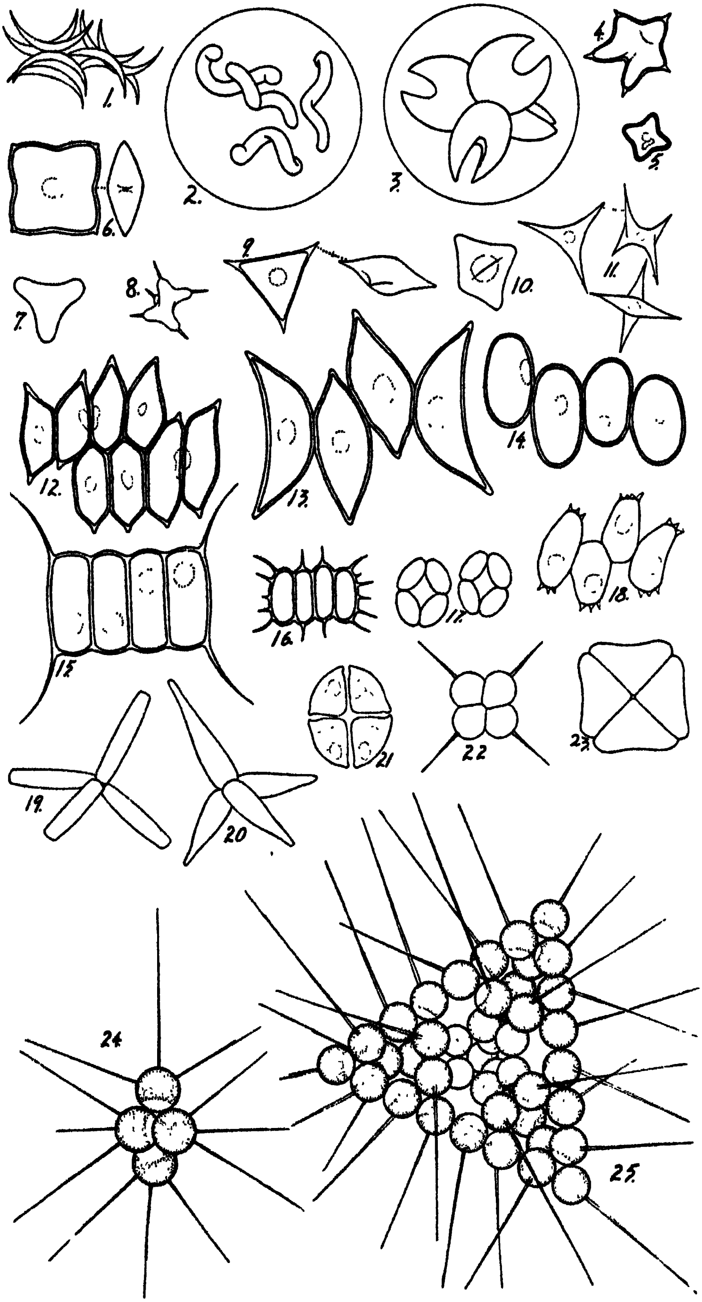


PLATE IX

1. *Vaucheria geminata.* × 63
2. *Vaucheria sessilis.* × 63.
3. *Zygnema insigne.* × 83.
4. *Spirogyra protecta.* × 41.
5. *Spirogyra malmeana.* × 41.
6. *Spirogyra punctiformis.* × 31.
7. *Spirotaenia parvula.* × 333.
8. *Roya obtusa.* × 125.
9. *Netrium digitus.* × 63.
10. *Closterium subulatum.* × 63.
11. *Closterium acerosum.* × 29.
12. *Closterium moniliforme.* × 29.
13. *Spirogyra decimina.* × 166.
14. *Pleurotaenium Ehrenbergii.* × 63.
15. *Penium curcubitum.* × 166.
16. *Cosmarium reniforme.* × 166.
17. *Cosmarium polymorphum.* × 166.
18. *Cosmarium punctulatum.* × 166.
19. *Cosmarium circulare.* × 166.
20. *Cosmarium pseudobroomei.* × 166.
21. *Cosmarium Schliephackeanum.* × 83.
22. *Euastrum verrucosum.* × 125.

PLATE IX

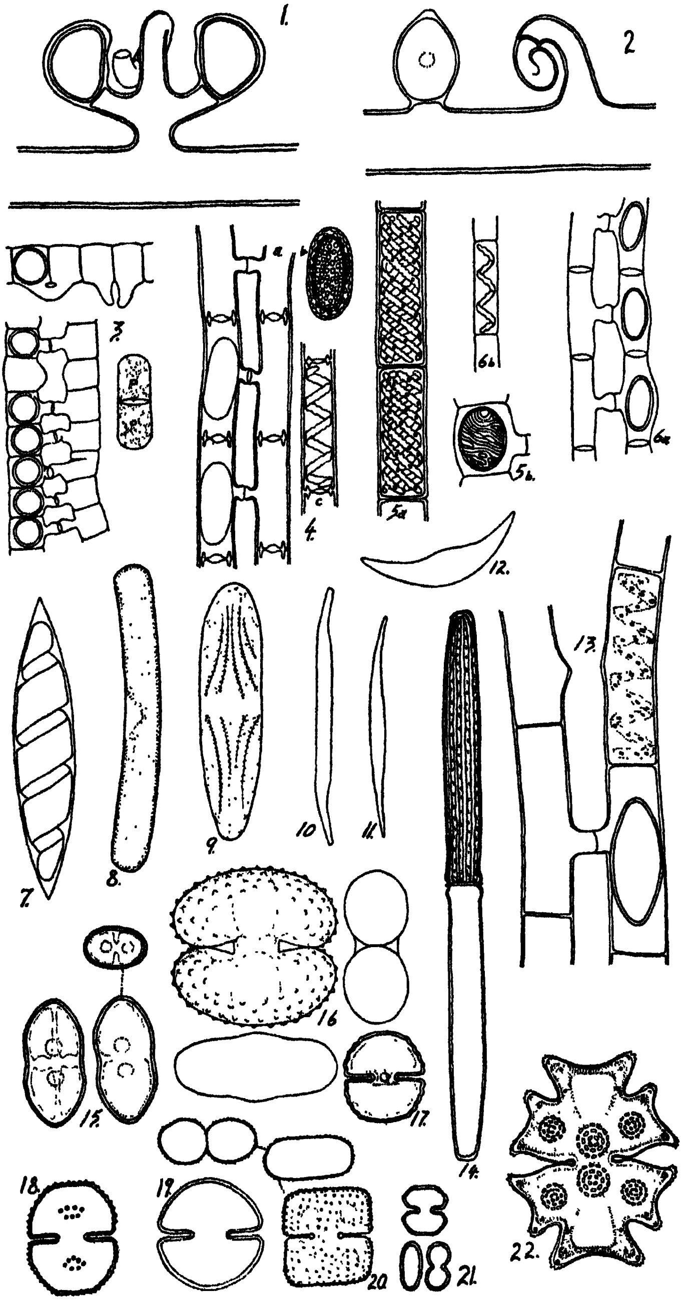


PLATE X

1. *Cosmarium polygonum.* × 166.
   (For figures 1*b* and 1*c* see text.)
2. *Cosmarium granatum.* × 166.
   (For figures 2*b*, 2*c*, see text.)
3. *Cosmarium impressulum.* × 166.
4. *Cosmarium sexpapillosum* sp. nov. × 166.
5. *Cosmarium Nymannianum?* × 166.
6. *Cosmarium humile* var. *lacustre.* × 166.
7. *Cosmarium crenatum.* × 166.
8. *Micrasterias americana.* × 63.
9. *Staurastrum paradoxum.* × 166.
10. *Glenodinium oculatum.* × 250.
11. *Glenodinium pulvisculus.* × 250.
12. *Euglena intermedia.* × 125.
13. *Euglena spirogyra.* × 166.
14. *Euglena acus.* × 166.
15. *Euglena rubra.* × 125.
16. *Euglena truncata* var. *baculifera* var. nov. × 125.
17. *Euglena alata* sp. nov. × 125.
18. *Euglena deses.* × 125.
19. *Euglena spiroides.* × 125.
20. *Euglena Grisoli.* × 125.
21. *Euglena fusca.* × 125.
22. *Euglena geniculata.* × 125.
23. *Euglena tripteris.* × 125.
24. *Euglena torta.* × 125.
25. *Euglena viridis.* × 125.
26. *Euglena proxima.* × 125.
27. *Euglena variabilis.* × 125.
28. *Euglena acutissima.* × 125.
29. *Euglena flava.* × 125.

PLATE X

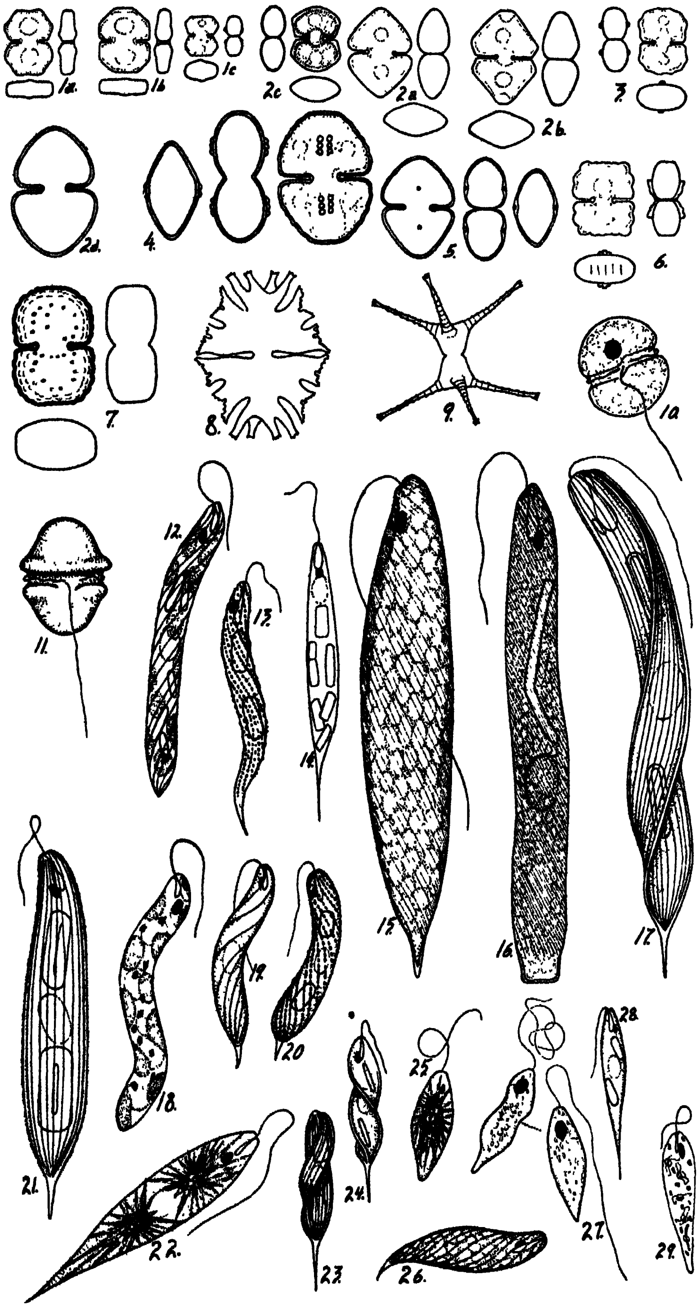


PLATE XI

1. *Lepocinclis ovum.* × 250.
2. *Lepocinclis ovum* var *globula.* × 250.
3. *Lepocinclis ovum* var. *palatina.* × 250.
4. *Lepocinclis Butschlii* var. *angustata.* × 250.
5. *Lepocinclis acicularis.* × 250.
6. *Lepocinclis Steinii.* × 250.
7. *Lepocinclis turbiniformis.* × 250.
8. *Lepocinclis fusiformis.* × 250.
9. *Lepocinclis texta.* × 250.
10. *Lepocinclis truncata.* × 250.
11. *Phacus longicauda.* × 250.
12. *Phacus longicauda* var. *torta.* × 250.
13. *Phacus anacoelus.* × 250.
14. *Phacus acuminata.* × 250.
15. *Phacus pusilla.* × 250.
16. *Phacus caudata.* × 666.
17. *Phacus pyrum.* × 666.
18. *Phacus triqueter.* × 250.
19. *Phacus hispidula.* × 250.
20. *Phacus acuminata ?* × 250.
    (For figures 20*a*, *b* and *c*, see text.)
21. *Phacus inflata* sp. nov. × 250.

PLATE XI

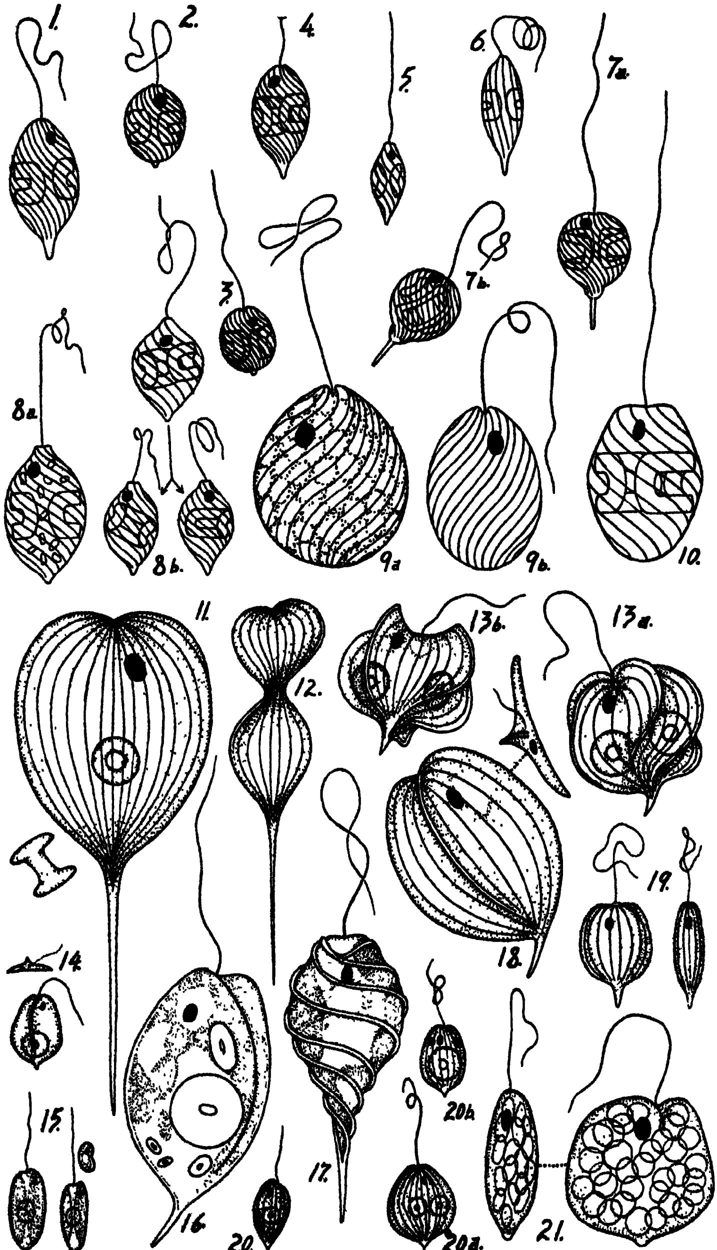
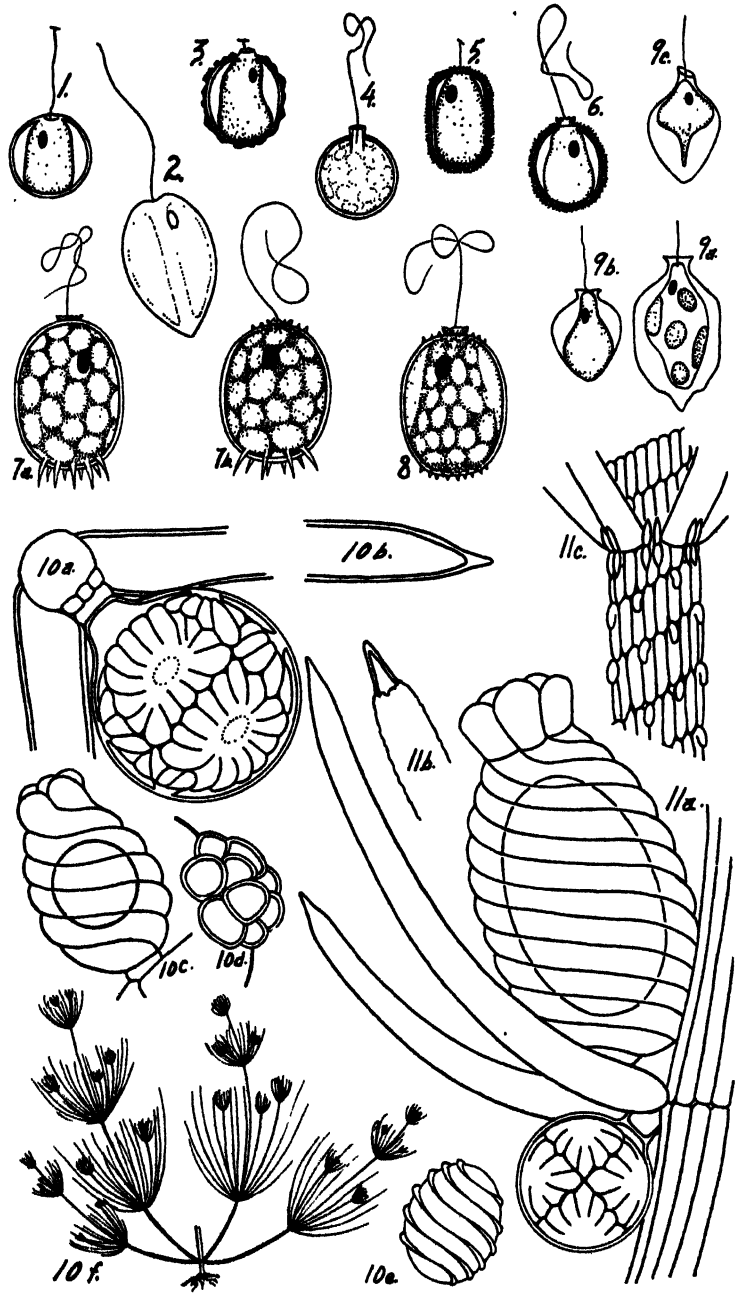

1.
2.
4
5.
6.
7a.
3.
7b.
8a.
8b.
9a
9b.
10.
11.
12.
13b.
13a.
18.
19.
14
15.
16.
17.
20b.
20a.
20c
21.

PLATE XII

1. *Trachelomonas volvocina.* × 250.
2. *Cryptoglena pigra.* × 666.
3. *Trachelomonas oblonga.* × 666.
4. *Trachelomonas volvocina* var. *cervicula.* × 250.
5. *Trachelomonas hispida* var. *cylindrica.* × 250.
6. *Trachelomonas hispida.* × 250.
7. *Trachelomonas armata.* × 250.
8. *Trachelomonas pulchra* var. *elongata.* × 250.
9. *Trachelomonas Vermonti.* × 250.
10. *Nitella opaca.*
    (*a*) Antheridum. × 33.
    (*b*) Leaf tip. × 33.
    (*c*) Oögonium without corona. × 33.
    (*d*) Corona. × 166.
    (*e*) Zygote. × 33.
    (*f*) Habit sketch. × .12.
11. *Chara foetida.*
    (*a*) Portion of a thallus bearing an oögonium and an antheridium. × 33.
    (*b*) Leaf tip. × 33.
    (*c*) Portion of stem showing stipules and cortical outgrowths. × 16.6.

PLATE XII



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Effects of Certain Alkaloids on the Growth of *Aspergillus niger* and *Rhizopus nigricans*

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ABSTRACT: A study was made on the effect of caffeine, caffeine citrate, and the sulphates of strychnine and quinidine on the growth and sporulation of *Aspergillus niger* van Tieghem and *Rhizopus nigricans* Ehrhart on Coon's nutrient solution. The results showed that, in general, the rate and amount of growth was increased by strychnine and quinidine and decreased by caffeine and caffeine citrate. Sporulation was retarded or completely suppressed by all of the above alkaloids except strychnine.

A second study was made to determine the ability of *Aspergillus niger* to assimilate strychnine-carbon and nitrogen. The fungus was grown on different nutrient solutions in which the only carbon and nitrogen containing compounds present were as follows: strychnine and KNO_3; dextrose and strychnine; dextrose and KNO_3; dextrose, KNO_3 and strychnine. The results of this experiment showed that strychnine-carbon, when the only carbon compound present, is unavailable and that strychnine-nitrogen is utilized to a slight extent in the absence of other nitrogen-containing compounds.

A study was then made to determine the ability of *Aspergillus niger* to assimilate strychnine-carbon and nitrogen in the presence of dextrose and potassium nitrate. The amount of growth obtained on nutrient solutions with varying ratios of dextrose and KNO_3 and equal amounts of strychnine was compared with that obtained on control solutions without the strychnine. The results showed that the increase in rate and amount of growth due to the presence of strychnine was as great in solutions with a low, as in those with a high, dextrose/KNO_3 ratio. Moreover, quantitative analysis of the culture solutions showed that their strychnine content remained practically unchanged. The results of these experiments indicate that strychnine has an intense stimulating action on growth and very little, if any, nutritive value.

INTRODUCTION

In undertaking a study of the effects of alkaloids on the growth of fungi, one naturally wonders as to the origin and rôle of these substances within the plants which produce them.

The alkaloids are rather limited in their distribution in the plant kingdom, occurring, for the most part, in the Leguminosae, Papa-

veraceae, Ranunculaceae, Rubiaceae, and Solanaceae. They may occur in solution in the cell sap in the young parenchyma or may be stored in older tissue in the solid state. They are generally found in the seeds and fruits, but some occur in the leaves, stems and roots (Hass and Hill, 13).

The origin of the alkaloids in the plant is not definitely known. Some consider that they arise in the formation of proteins, while others believe that they are formed in the disintegration of the proteins. They are thought to be nitrogenous waste products by most investigators.

As to the rôle of the alkaloids within the plants which produce them, there have been differences in opinion among the investigators. Some have ascribed to these substances a protective function against the attack of animals. The literature on this subject indicates that the protective function, when performed, is only an incidental one.

Some have ascribed to the alkaloids a nutritive value due especially to the nitrogen contained in their molecules. A part of the evidence bearing on this subject comes from investigations of the localization of alkaloids, their quantitative variations, mode of formation, migration during the course of vegetation and of seed germination, variations provoked under the influence of different external factors, and grafting experiments.

The literature of the above-mentioned investigations has been contributed by numerous investigators and summarized by Goris (*12*). From the following brief summary of these investigations, taken from Goris, one may obtain some idea as to the general nature of this work and its bearing on the rôle of alkaloids.

The localization of alkaloids has been studied by microchemical reactions produced within the tissues of the plant under the influence of various reagents. Some of these reagents form insoluble precipitates with the alkaloids while others give beautiful color reactions which are, in many cases, of but short duration. These tests give but little information concerning the actual amount of alkaloid present.

The alkaloids have been found frequently and in considerable amount in the latex vessels of the Papaveraceae and Fumariaceae, the secreting cells of *Conium maculatum* L. and associated with raphides in the Amaryllidaceae.

In general, the alkaloids are found in regions where cellular activity is greatest.

From his study of the work on localization, Goris concludes that

the alkaloids are translocated, to a great extent, to external tissues of the stem which are later sloughed off. Goris also accepts the presence of alkaloids largely in the secretory tissue as evidence that they are not reserve compounds. Several hypotheses, based on similarities and differences between structural formulae of alkaloid molecules and those of various other compounds found in plants, have been advanced to explain the mode of formation of alkaloids. The most commonly accepted hypothesis seems to be that of Winterstein and Trier (*34*), who consider the alkaloids as waste products arising from the metabolism of albuminous material. The origin of the purine bases from the decomposition of nucleoproteins is commonly accepted. It is interesting to note the frequency with which certain cyclic nitrogenous groups are common to both alkaloids and aminoacids, for example, proline and nicotine both contain the pyrrolidine ring while the indole ring is common to tryptophane and brucine.

Cimician and Ravenna (*3*) injected various nitrogen compounds into plants which normally contain alkaloids. The alkaloid content of these plants was determined after a time and compared to controls which had not been injected.

The nicotine content of the tobacco plant injected with asparagine was greater than that of the control plant.

Additional evidence bearing on the nutritive value of alkaloids comes from experiments on the effects of these substances on seed germination and the growth of different plants. This problem dealing with the effects of alkaloids on the growth of fungi warrants a brief review of the literature on the previous work on this subject.

REVIEW OF LITERATURE

According to Wood, Remington, and Sadtler (*36*) strychnine sulphate is used in practical medicine in doses of one fortieth to one twentieth grain (0.0016 to 0.003 gm.). One quarter of a grain has been known to produce death within a few hours.

Quinidine sulphate has a similar physiological action to that of quinine. Antimalarial dose, one gram.

Caffeine is a valuable remedy in practical medicine as a cerebral and cardiac stimulant and as a diuretic. Dose, from three to eight grains (0.2 to 0.5 gm.).

Caffeine citrate is possessed of the therapeutic properties of caffeine. Dose, one teaspoonful (3.9 gm.).

Overton (*26*) observed that caffeine and strychnine quickly penetrated the protoplasm of plant and animal cells.

Marcacci (*19*) found that atropine and morphine produced a favorable action on lactic acid fermentation which was retarded by quinine, veratrine, cinchonamine, and to a still greater extent by strychnine. All of the above alkaloids produced a favorable action on alcoholic fermentation except cinchonamine and quinine.

Considerable work has been done on the effect of alkaloids on the growth of the higher plants. The experimental plants were grown in nutrient solutions, sand, or soil to which the alkaloid was added. The controls were grown in nutrient solutions without the alkaloids or in sand or soil sprinkled with pure water instead of the alkaloid solution. A large number of different plants and alkaloids have been used.

A number of investigators, Sawa (*29*), Lutz (*16*), Strake (*30*), Weyl (*33*), Marcet (*20*), Bouchardat (*2*), Wolf and Knop (*35*), Marcacci (*19*), Otto (*25*), Detoni (*8*), and DeVarigny (*9*), found that the alkaloids produce a toxic or unfavorable action on the growth of the higher plants. Princeps (*27*) found that plant extracts of alkaloid-containing plants produced an injurious action on the same plants from which they were obtained.

It has been observed by Strake (*30*), Marcet (*20*), Bouchardat (*2*), Wolf and Knop (*35*) and Marcacci (*19*) that the toxic action varies with different alkaloids.

DeVarigny (*9*), Bouchardat (*2*), and Otto (*25*) found that the toxic action of the alkaloids varies inversely with the fertility of the soil in which the experimental plants are grown. Goris (*12*) attributes the increased resistance of the plant growing in fertile soil to the greater abundance of nitrate which enables the plant to utilize the alkaloid. It seems to the writer that the colloidal action of the soil may also play a part in decreasing the injurious action of the alkaloids.

Reveil (*28*) found that plants sprinkled with atropine solutions grew more vigorously than the controls. He identified the alkaloid in the experimental plants and concluded from his work that the alkaloid assimilated disappeared rapidly during the course of growth. His experiments were repeated by Marcacci (*19*) and DeVarigny (*9*), who were unable to confirm them. Wolf and Knop (*35*) were unable to identify the alkaloid in the experimental plants with which they worked.

Goeppert (*11*) observed that seedlings of oats, wheat, peas, and cress sprinkled with infusions of belladonna developed as well as those sprinkled with pure water. DeVarigny (*9*) obtained experimental plants superior to the controls by adding atropine solution to

the soil. When sand was used instead of soil the experimental plants were inferior to the controls. Marcacci (*19*) observed that *Lemna minor* is uninjured by morphine and atropine. Bokorny (*1*) states that the higher plants are very little susceptible to caffeine.

DeToni (*8*) grew *Coix lacryma* in nutrient solutions which contained strychnine sulphate as the only nitrogen-containing compound, but with only partial results.

Lutz (*15*) germinated seeds in washed and sterilized sand moistened with a nutritive solution containing an alkaloid. He found that during the development of the seedling there was a loss instead of a gain in nitrogen. He concluded that the alkaloids when used alone as a source of nitrogen were unassimilable.

Marcacci (*19*) observed that the roots are the most susceptible part of the plant to the injurious action of alkaloids.

Marcacci (*19*) studied the influence of different alkaloid solutions, which varied in concentration from 0.1 to 0.005 percent, on the germination of different seeds. He observed a toxic action which varied with the nature of the alkaloid.

Mirande (*22*) obtained good germination of hemp seeds when treated with valerianate of quinine in a dilution of 1-2500, but the seedlings were inferior to the controls.

DeVarigny (*9*) studied the action of 1-500 and 1-1500 solutions of atropine on the germination of different seeds. According to the results obtained, the seeds could be divided into three categories: those for which atropine was unfavorable, indifferent, or favorable.

Cornevin (*7*) studied the action of different alkaloids on the germination of different seeds. He found that in some cases the germination of the seeds was retarded by the alkaloid, in some cases it was unaffected, and in others germination was advanced with a greater percentage of the seeds germinating.

Mosso (*23*) accurately determined the doses of different alkaloids necessary to produce a stimulating action on germination. He prepared solutions with concentrations varying from 2 to 0.0001 percent. He germinated seeds of *Phaseolus multiflorus* Willd. on cotton placed in the bottom of a vessel and saturated with the different alkaloid solutions. He found the optimum concentration for each alkaloid which produced seedlings far superior to the controls. The growth of the seedlings decreased as the concentration of alkaloid was increased above, or decreased below, the optimum value. The optimum concentrations for the different alkaloids are: chlorohydrate of morphine, 0.001 percent; nicotine solutions, 0.01 percent;

strychnine solutions, 0.005 percent; cocaine solutions, 0.01-0.001 percent; atropine solutions, 0.0005 to 0.0001 percent; and in caffeine salicylate solutions all seedlings were inferior to the controls. The negative results obtained in caffeine solutions were attributed to antifermentative actions of salicylic acid.

These experiments show that in high concentrations the alkaloids have a toxic action and in weak doses an exciting action on seed germination. The concentrations which are injurious or beneficial vary with each alkaloid and with each plant.

Bokorny (*1*) found from 0.01 to 0.1 percent solutions of strychnine injurious to algae and small water animals. He states that caffeine is a weak poison for algae and infusoria.

Comere (6) grew *Ulothrix subtilis* and *Spirogyra crassa* Kutz in a nutrient solution devoid of nitrogen compounds and to which he progressively added alkaloid salts. Morphine, atropine, and cocaine were directly assimilated in a decreasing order. The salts of quinine were also assimilated while those of strychnine were toxic. It required a concentration of 0.002 percent to kill Spirogyra and 0.008 percent to kill Ulothrix.

Nobecourt (*24*) cultivated *Botrytis cinerea* Pers. on Raulins liquid containing varying amounts of nicotine, sulphates of atropine and quinine, and aconitine. He found that nicotine sulphate in a concentration of $^{25}/_{1000}$ and atropine sulphate in a concentration of $^{20}/_{1000}$ did not hinder the growth of this fungus. Growth was not retarded by a concentration of $^{10}/_{1000}$ of quinine sulphate; but resulted in little thalli with few conidiophores by a concentration of $^{20}/_{1000}$ and completely inhibited by a concentration of $^{30}/_{1000}$. Growth was visibly hindered by aconitine in a concentration of $^{2}/_{1000}$, and greatly reduced by a concentration of $^{4}/_{1000}$. A concentration of $^{10}/_{1000}$ did not prevent the germination of spores, which was completely inhibited by a concentration of $^{20}/_{1000}$.

Yasuda (*37*) found that the growth of *Penicillium glaucum, Aspergillus niger, Botrytis cinerea* and *Mucor stolonifer* was increased by the addition of the hydrochlorides of cocaine, quinine, cinchonine, morphine, codine, and strychnine to Richards nutrient solution. The alkaloids were used in concentrations varying from 0.2 to 2 percent. As the concentration of alkaloid was increased, the conidiophores and sporangiophores became thinner and shorter. Conidium and sporangium formation was entirely suppressed and replaced by clamydospores when the optimum concentration for fungus-vegetation was surpassed. The weakest alkaloid for the

fungi under consideration was the hydrochloride of morphine, while the strongest was that of cocaine. The fungi listed in order of their decreasing resistance to alkaloids are: *Penicillium glaucam, Aspergillus niger, Botrytis cinerea,* and *Mucor stolonifer.*

Ehrlich (*10*) grew different fungi on a mineral nutrient solution to which he added different alkaloids as the only nitrogen-containing compounds and ethyl alcohol or invert sugar as a source of carbon in concentrations of 0.2 and 2 percent, respectively. A control series without the alkaloid was run at the same time.

The fungi used were: *Oidium lactis, Aspergillus niger, Penicillium glaucum, Willia anomala, Pichia farinosa,* a mixed culture obtained by exposing the culture solution to the air, and an unknown species of wine yeast. The alkaloids used were: pyridine, piperidine bitartrate, coniine, nicotine, cinchonine, quinine, brucine, cocaine and morphine.

Ehrlich determined the amount of fungus dry weight produced and nitrogen content of the fungus substance at the end of a growing period, which varied from 3 to 12 months.

He obtained only a small amount of growth, which was least in the yeast cultures and greatest in the mixed cultures. A small amount of nitrogen corresponding to the amount of growth was recovered from the fungus dry substance. He concluded that this nitrogen was obtained by the organism from the decomposition of the alkaloid. This decomposition was greater in the mixed cultures under the united action of several organisms. He also obtained the aromatic odor of ester compounds in some cases, and traces of ammonia with Nessler's reagent in others. The checking of growth which he obtained was attributed to the poisonous action of the decomposition products of the alkaloids.

Lutz (*16*) grew *Aspergillus niger* and *Penicillium glaucum* on different alkaloid solutions and control solutions with the same elemental composition as that of Raulin's solution. The relative amounts of fungus growth in grams of dry weight produced on the different solutions were used as criteria of the nutritive value of the solutions.

From the results of this investigation Lutz concluded that the alkaloids when used alone as a source of nitrogen were not assimilated by fungi, but were assimilated in considerable quantities in the presence of nitrate or ammonia-nitrogen.

In a later work, Lutz (*17*) set up an experiment to determine whether fungi could use alkaloids alone as a source of nitrogen after growth had been started on ammonium nitrate and to make quanti-

tative determinations of the amount of alkaloids utilized in both the presence and absence of ammonium nitrate.

The fungi used were *Aspergillus niger*, *A. repens*, and *Penicillium glaucum*. The alkaloids used were the hydrochlorides of cocaine, morphine and quinine.

He found some utilization of alkaloids from solutions whose nitrogen was only in the form of alkaloid-nitrogen. This he attributes to traces of ammonium nitrate absorbed from Raulin's solution before replacement by the alkaloid solution and which could not be washed from the mycelium. The amount of growth and of alkaloid utilized were considerably greater in the alkaloid solutions containing ammonium nitrate. He reports an absorption of 0.947 gm. of chlorohydrate of cocaine and 0.400 gm. of chlorohydrate of quinine from 50 cc. of culture solution in 26 days.

Lutz suggests that the alkaloids are transformed into albumins in the presence of ammonium nitrate. He does not consider them as either reserve compounds or waste products in the strict sense of the word, but as intermediate compounds between the albumins and mineral nitrogen compounds.

From the literature reviewed on the alkaloids it appears that these compounds when used in high dilution have an accelerating action on growth and when used in high concentrations a toxic action. The salts of the alkaloids seem to be less toxic than the pure alkaloids. The intensity of action varies with different alkaloids and with different experimental plants. In the higher plants the roots and root hairs seem to be the most sensitive part of the plant to the toxic action. The fungi seem to be least susceptible to the toxic action of the alkaloids. In many cases the fungi seem to be benefited by high concentrations of these substances, while the algae and higher plants are killed by very dilute solutions. It also appears from the work of Ehrlick (l. c.) that some of the fungi are able to assimilate small quantities of alkaloids in the absence of other nitrogen-containing compounds. According to Lutz (l. c.) the alkaloids may be assimilated in large quantities in the presence of nitrate or ammonia nitrogen. Klotz (*14*) has shown that the nitrogen content of the fungus varies with the nitrogen and carbon sources of the medium, the length of incubation, rate of growth, and the H-ion concentration of the medium. A more acid medium prevents autolysis and thereby tends to increase the nitrogen content of the fungus. A rapid growth is accompanied by a lower percent of nitrogen in the fungus. It follows from this that any substance which

accelerates the rate of growth, if only by a purely stimulating action, would effect a more efficient utilization of the nitrogen compounds in the production of fungus dry weight.

With these results of previous investigators in mind the writer has undertaken a study of the effect of caffeine, quinidine, and strychnine on the growth of *Rhizopus nigricans* and *Aspergillus niger*.

EXPERIMENTAL EFFECTS OF ALKALOIDS ON GROWTH AND SPORULATION

MATERIAL AND METHOD

The effect on growth was determined by growing a fungus on 100 c.c. portions of a nutrient medium containing varying amounts of the alkaloid under investigation and making dry weight determinations at regular intervals following inoculation. The relative time required from inoculation until the first appearance of visible mycelium and sporangia was used as a measure of the effect of the alkaloid on germination and sporulation.

The fungi used, *Rhizopus nigricans* Ehrhart and *Aspergillus niger* van Tieghem, were obtained from the stock cultures of the Department of Botany, University of Kansas. These organisms show considerable difference in their ability to use nitrate-nitrogen, it being readily assimilated by *Aspergillus niger*, but only slightly available to *Rhizopus nigricans*.

Coon's solution, as described by Young and Bennett (*38*), was modified by increasing the sugar content to 2 percent, and used for a culture medium to avoid difficulties of chemical analysis and interpretation of results which would arise from using a culture medium containing complex organic-nitrogen compounds.

NUTRIENT SOLUTION

$MgSO_4$	1.23 grams
KH_2PO_4	2.72 grams
KNO_3	2.02 grams
Dextrose	20.00 grams
Distilled water	1000 c.c.

The above nutrient solution yields a good growth of *Aspergillus niger*, but only a very scant growth of *Rhizopus nigricans* is obtained unless the solution is reinforced with a more available form of nitrogen.

The following alkaloids were used: sulphates of strychnine and quinidine, caffeine citrate, and caffeine base. The alkaloids were

obtained from the Merck Chemical Company, weighed out in the proper amounts and used without previous drying or purification. Alkaloid solutions of varying concentrations were prepared by adding the alkaloid in different amounts to 100 c.c. portions of the nutrient solution. These 100 c.c. portions were placed in 125 c.c. Erlenmeyer flasks, plugged with cotton, and sterilized in an Arnold steam sterilizer.

A heavy suspension of the spores was obtained by growing the fungus on potato dextrose agar and suspending the spores in distilled water. A drop of the heavy spore suspension was added to each flask with a looped inoculating needle or dropped from a burette. All flasks were inoculated at the same time and from the same spore suspension.

Dry-weight determinations were made at the end of a twenty-three-day growing period in the experiments with *Rhizopus nigricans* and at regular seven-day intervals following inoculation in the experiments with *Aspergillus niger*. The mycelium was obtained by filtering the solution through Gooch crucibles which previously had been partially filled with asbestos fibers, dried to constant weight in a desiccator and weighed. The mycelium was washed by running distilled water through the filter. The filtering was hastened by using a filter flask connected to a vacuum pump. The mycelium obtained from five culture flasks was used for each dry-weight determination in the experiments with *Rhizopus nigricans*. In the experiments with *Aspergillus niger* the mycelium from two culture flasks was used for each determination. The crucibles with mycelium and spores were dried and reweighed as described above. The increase in weight represents the amount of fungus growth.

RESULTS

Table I shows the effect of different concentrations of strychnine sulphate, caffeine, caffeine citrate, and quinidine sulphate on the growth of *Rhizopus nigricans* at room temperature for a twenty-three-day growing period. Column I shows the alkaloid concentrations of the different nutrient solutions. Columns II, III, IV, and V show the amount of growth obtained in the strychnine sulphate, caffeine, caffeine citrate, and quinidine sulphate solutions, respectively. The small amount of growth obtained was due to the inability of *Rhizopus nigricans* to assimilate either the alkaloid or nitrate-nitrogen as was later demonstrated by adding peptone to the culture solution, in which case a vigorous growth was obtained.

The table shows that the amount of growth was greater in the

nutrient solution to which strychnine sulphate was added than in the nutrient solution alone; the amount of growth varying directly with the concentration of strychnine sulphate and inversely with the concentration of caffeine, caffeine citrate, and quinidine sulphate. Sporulation failed to occur in all of the above solutions.

Table II shows the effect of different concentrations of strychnine sulphate on the growth of *Aspergillus niger* at room temperature. Column I shows the different concentrations of strychnine sulphate used. The amount of growth obtained in each solution after 7-, 14-, 21-, 28-, and 35-day periods are given in columns II, III, IV, V, and VI, respectively. Tables III, IV, and V show the effect of varying concentrations of quinidine sulphate, caffeine citrate and caffeine, respectively, on the growth of *Aspergillus niger*. These results were obtained by the same method of experimentation and the data treated the same as those in table II.

The amount of growth varied directly with the concentration of strychnine and quinidine sulphate as shown in tables II and III. The action of quinidine was different from that of strychnine in that in the former there was considerable initial lag in the rate of growth in solutions with concentrations above 0.15 percent. The length of the initial lag, which varied directly with the alkaloid concentration, reached a maximum value of 49 days in the highest concentration used.

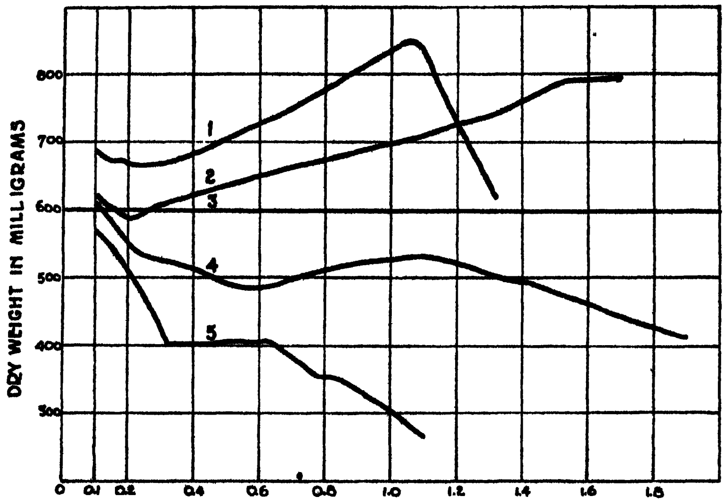
Table IV shows that caffeine citrate in concentrations of 0.05 percent or less may cause a slight increase in growth over the control solution, but in higher concentrations it seemed to have a rather marked inhibiting effect. Caffeine produces a depressing action on growth in concentrations of 0.05 to 1.00 percent, which increases in direct proportion to the concentration as is shown in table V.

Table VI shows the effect of varying concentrations of different alkaloids on the time interval in days required between inoculation and the first appearance of growth and sporulation in cultures of *Aspergillus niger*. Column I gives the concentration of alkaloid in percent. Column II shows the number of days required for visible growth to appear in solution with different concentrations of strychnine sulphate. Columns III, IV, and V show the same for solutions of quinidine sulphate, caffeine citrate, and caffeine, respectively. The time required for sporulation in strychnine sulphate, quinidine sulphate, caffeine citrate, and caffeine solutions of varying concentrations is shown in columns VI, VII, VIII, and IX, respectively.

The time required for the first appearance of growth and sporulation in strychnine sulphate solutions of all concentrations was the

same as that for the control solution. In the solutions of quinidine sulphate, caffeine citrate and caffeine with concentrations above 0.10 percent, a longer time was required than in the control, the length of time varying directly with the alkaloid concentration. In the two highest concentrations of caffeine, sporulation was completely suppressed.

Figure I was taken from the results given in tables II, III, IV and V and shows the maximum dry weight produced with each alkaloid in each of the concentrations used. The alkaloid concentrations



1-QUINIDINE 2-STRYCHNINE 3-CONTROL 4-CAFFEINE CITRATE 5-CAFFEINE

FIG. I: GRAPH SHOWING AMOUNT OF GROWTH IN DIFFERENT ALKALOID SOLUTIONS.

are given in percentages. The amounts of dry weight produced are given in milligrams. This figure shows at a glance that strychnine and quinidine sulphates increased, while caffeine citrate and caffeine decreased dry-weight production. In the strychnine sulphate solutions the amount of growth increased with increased concentration of strychnine sulphate up to 1.80 percent, which was the highest concentration used. In the quinidine sulphate solutions the amount of growth likewise varied directly with the alkaloid concentration up to 1 percent and then abruptly decreased. This abrupt decrease in amount of growth may be traced to the exceedingly long initial lag in the growth rate which is produced by high concentrations of quinidine. From these results one may conclude that strychnine and quinidine sulphates increase, while caffeine citrate and caffeine

decrease the amount of growth. The action of strychnine and quinidine may be that of a stimulus or nutrient or both. If these alkaloids have a nutritive value, it may be either the nitrogen or carbon or both that is assimilated.

TABLE I

Effect of different alkaloids on the growth of *Rhizopus nigricans* at room temperature

I	II Strychnine sulphate.	III Caffeine.	IV Caffeine citrate.	V Quinidine sulphate.
Alkaloid concentration, percent.	Growth in grams dry wt.	Growth in grams dry wt.	Growth in grams dry wt.	Growth in grams dry wt.
0.000	0.0112	0 0112	0.0112	0.0112
0.05	0.0129	0.0127	0.0104	0.0095
0.10	0.0152	0.0106	0.0101	0.0068
0.20	0.0176	0.0092	0.0096	0.0059
0.30	0.0194	0.0086	0.0068	......
0.40	0.0186	......	0.0021	......
0.50	0.0256	......	......	......
0.75	0.0358	......	......	......

TABLE II

Effect of strychnine sulphate on the growth of *Aspergillus niger* at room temperature

I	II	III	IV	V	VI
Days	7	14	21	28	35
Alkaloid concentration, percent.	Growth in grams dry wt.	Growth in grams dry wt.	Growth in grams dry wt.	Growth in grams dry wt.	Growth in grams dry wt.
0.00	0.1342	0.3855	0.5637	0.5710	0.5984
0.05	0.1634	0.3832	0.5603	0.5728	0.6162
0.15	0.1596	0.3922	0.5866	0.5933	0.5945
0.30	0 1685	0.3907	0.6043	0.5983	0.6178
0.50	0.2220	0.4738	0.6725	0 6111	0 6483
0.75	0.1933	0.4851	0.6616	0.6715	0.6810
1.01	0.1844	0.5046	0.7158	0.7060	0 7023
1.40	0.2612	0.4876	0 7410	0.7667	0.7890
1.80	0.1517	0.5484	0.7552	0.8017	0.7274

TABLE III

Effect of varying concentrations of quinidine sulphate on the growth of *Aspergillus niger* at room temperature

I	II	III	IV	V	VI	VII
Days	7	14	21	28	35	42
Alkaloid concentration, percent.	Growth in grams dry wt.	Growth in grams dry wt.	Growth in grams dry wt.	Growth in grams dry wt.	Growth in grams dry wt.	Growth in grams dry wt.
0.00	0.1342	0.3855	0.5637	0.5710	0.5984	0.5883
0.05	0.1686	0.2320	0.5677	0.6093	0.6816	....
0.15	0.1536	0.2876	0.5667	0.6044	0.6717	....
0.30	0.1124	0.2747	0.5704	0.6434	0.6864	....
0.50	0.0674	0.3135	0.5573	0.7011	0.7334	....
0.75	....	0.2004	0.5624	0.5717	0.7824	0.7416
1.00	....	....	0.1686	0.3953	0.7005	0.8616
1.25	....	....	....	0.1290	0.1712	0.6102
1.50*	....	....	....	....	....	....

* First appearance of growth 49 days after inoculation.

TABLE IV

Effect of varying concentrations of caffeine citrate on the growth of *Aspergillus niger* at room temperature

I	II	III	IV	V	VI	VII
Days	7	14	21	28	35	42
Alkaloid concentration, percent.	Growth in grams dry wt.	Growth in grams dry wt.	Growth in grams dry wt.	Growth in grams dry wt.	Growth in grams dry wt.	Growth in grams dry wt.
0.00	0.1342	0.3855	0.5637	0.5710	0.5984	0.5883
0.05	0.1158	0.3984	0.5810	0.5802	0.6056	....
0.15	0.1210	0.4126	0.5399	0.5290	0.5143	....
0.30	0.1672	0.4314	0.5248	0.4977	0.4621	....
0.50	0.0920	0.4100	0.4889	0.4754	0.4675	....
0.75	0.0772	0.3850	0.5011	0.5180	0.4928	....
1.05	0.0589	0.2667	0.5246	0.5321	0.5257	....
1.40	....	0.1012	0.4356	0.4924	0.4410	0.4985
1.80	....	0.0364	0.3092	0.3991	0.4205	0.4736

TABLE V

Effect of varying concentrations of caffeine on the growth of *Aspergillus niger* at room temperature

I	II	III	IV	V	VI	VII
Days	7	14	21	28	35	42
Alkaloid concentration, percent.	Growth in grams dry wt.	Growth in grams dry wt.	Growth in grams dry wt.	Growth in grams dry wt.	Growth in grams dry wt.	Growth in grams dry wt.
0.00	0.1342	0.3855	0.5637	0.5710	0.5984	0.5883
0.05	0.1396	0.3092	0.5386	0.5662	0.5783	....
0.10	0.1262	0.3152	0.5330	0.5479	0.5240	....
0.25	0.1456	0.2791	0.3958	0.3963	0.3938	....
0.40	0.1708	0.2432	0.3843	0.4199	0.4046	....
0.55	0.0960	0.2308	0.3670	0.4198	0.3719	....
0.70	0.0558	0.1875	0.3210	0.3607	0.3464	....
0.85	0.0346	0.1258	0.2642	0.3422	0.3314	....
1.00	....	0.1239	0.2280	0.2410	0.2744	0.2917

TABLE VI

Time required in days for the first appearance of growth and sporulation of *Aspergillus niger* at room temperature on different alkaloid solutions of varying concentrations

	Time required in days for first appearance of growth.				Time required in days for sporulation.			
I	II	III	IV	V	VI	VII	VIII	IX
Alkaloid concentration, percent.	SS	QS	CC	C	SS	QS	CC	C
0.000	1	1	1	1	3	3	3	3
0.100	1	1	1	1	3	3	3	3
0.625	1	2	2	2	3	5	11	25
1.175	1	5	5	2	3	8	15	....
1.750	1	180	12	5	3	183	34	....

SS—strychnine sulphate.
QS—quinidine sulphate.
CC—caffeine citrate.
C—caffeine.

NUTRITIVE VALUE OF STRYCHNINE

MATERIAL AND METHOD

In the previous experiment it was found that strychnine and quinidine sulphates accelerated and increased the growth of *Aspergillus niger*. This experiment was undertaken to determine the availability of strychnine-nitrogen and carbon.

Four different culture solutions were used. The different compounds and amount of each used in the culture solutions are as follows:

strychnine sulphate	15.00 grams
dextrose	20.00 grams
potassium nitrate	1.48 grams
potassium dihydrogen phosphate	2.72 grams
magnesium sulphate	1.23 grams
distilled water to	1,000 c.c.

Culture solution No. 1 contained all of the above compounds. The remaining solutions contained all of the above compounds with the following exceptions: in solution No. 2, the strychnine sulphate was omitted; in solution No. 3, the potassium nitrate was omitted; and in solution No. 4, the dextrose was omitted.

The procedure used in sterilization, inoculating, and making dry-weight determinations was the same as that used in the previous experiments.

The amount of growth obtained in the different culture solutions at the end of an 18-day growing period is given in Table VII. The amount of growth represents the mycelium obtained from four culture flasks.

TABLE VII

Availability of strychnine-nitrogen and carbon

SOLUTION NUMBER.	Carbon compounds present.	Nitrogen compounds present.	Dry weight, grams.
1	Dextrose and strychnine	Potassium nitrate and strychnine	1.1415
2	Dextrose	Potassium nitrate	1.0846
3	Dextrose and strychnine	Strychnine	0.0885
4	Strychnine	Potassium nitrate and strychnine	0.0009

The exceedingly small amount of growth obtained in culture solution No. 4 indicates that strychnine-carbon, when the only carbon compound present, is unavailable. The small amount of growth obtained in solution No. 3 indicates that strychnine-nitrogen can be utilized to a slight extent in the absence of other nitrogen com-

pounds. Good growth was obtained in solution No. 2 in which dextrose and potassium nitrate were used as sources of carbon and nitrogen, and still better growth was obtained in solution No. 1, in which strychnine was also present. From the results obtained in this experiment one might attribute the increase in growth in the presence of strychnine to the assimilation of strychnine-nitrogen rather than to a stimulating action of the strychnine. This question can be answered by studying the action of strychnine in culture solutions with varying ratios of dextrose and potassium nitrate.

To study this question a triangle experiment was set up using fifteen different culture solutions. Each of the fifteen different media contained 1.23 grams of magnesium sulphate and 2.72 grams of potassium dihydrogen phosphate per liter. In addition the solution contained varying amounts of the following compounds: dextrose, an available form of carbon; potassium nitrate, an available form of nitrogen; and strychnine sulphate, which contains both carbon and nitrogen, the availability of which was to be studied. These compounds varied in amount in such a way that each might be a limiting factor in growth. The ratio of dextrose to potassium nitrate varied in the different solutions from 1.25 to 80. Figure II shows the dextrose, potassium nitrate, and strychnine sulphate content of each of the fifteen different culture solutions in percentages. The different culture solutions are referred to by numbers given below the squares. 1,125 c.c. amounts of each of the fifteen different culture solutions were made up in 2-liter flasks and measured out in 75 c.c. portions into 125 c.c. Erylenmeyer flasks. After 30 minutes sterilization in the Arnold steam sterilizer on three successive days the H-ion was adjusted to Ph 4.8.

The procedure for preparing the spore suspension and inoculating was the same as that used in the previous experiment.

Dry-weight determinations were made with the procedure used in the previous experiment at 11-, 28-, 41-, and 54-day intervals following inoculation. The culture solution was removed from the filter flasks and the latter rinsed with sufficient distilled water to bring the solution up to its original volume. The culture solution was then divided into aliquots which were used for H-ion and quantitative sugar determinations, and a qualitative test for the presence of nitrates.

Ph readings were made with a Sargent quinhydrone acid Ph meter after heating the solution to expel any carbonic acid present. Quantitative sugar determinations were made by Benedict's method as given by Mathews (*21*). The presence of nitrates was indicated

STRYCHNINE SULPHATE, DEXTROSE, AND POTASSIUM NITRATE CONTENT OF THE 15 CULTURE SOLUTIONS IN PERCENT.

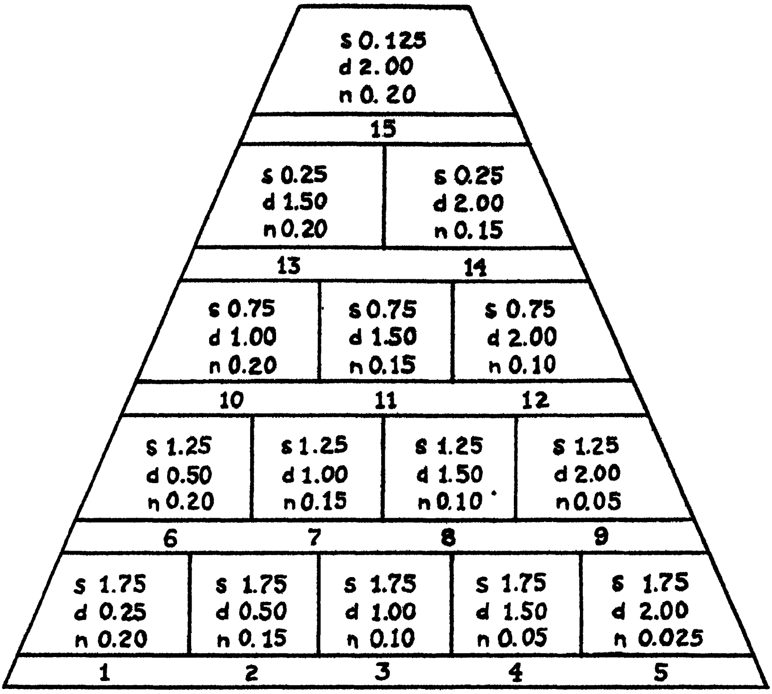


Figure II

s, strychnine sulphate. d, dextrose. n, potassium nitrate

Each of the above solutions contains 0.128 percent of magnesium sulphate and 0.272 percent of potassium dihydrogen phosphate.

by adding a few drops of a solution of diphenylamine to a few c.c. of the culture solution in a test tube and running chemically pure, concentrated sulphuric acid down the side of the tube. A deep blue ring at the juncture of the two liquids indicated the presence of nitrate.

RESULTS

Table VIII shows the amount of growth obtained with each of the 15 different culture solutions at the end of 11-, 28-, 41-, and 54-day growing periods. Each weight listed represents the total mycelium obtained from two culture flasks. The time intervals during which sugar and nitrates were still present in the different culture solutions are indicated by continuous and broken underlines, respectively.

The results indicate that there was practically no further increase in growth after the dextrose was exhausted in culture solutions Nos. 1, 2, 6, 7 and 10 (also 3 and 14, as indicated by their Ph values and dextrose/KNO_3 ratios) in which the dextrose disappeared before the nitrate. There was a gradual but slow increase in dry-weight production after the nitrate was exhausted in cultures Nos. 4, 5, 9 and 12 (also No. 8, as indicated by its Ph value and dextrose/KNO_3 ratio) in which the nitrate disappeared before the dextrose. This would indicate that strychnine-nitrogen may be slowly assimilated after the nitrate-nitrogen is exhausted, and does not preclude the possibility of its being assimilated along with the nitrate. On the other hand, the strychnine-carbon could only be assimilated along with the dextrose, for there is no further increase in growth after the sugar has been exhausted.

Table IX shows that there is a considerable increase in the acidity of the solution when the nitrate is exhausted before the dextrose in cultures Nos. 4, 5, 9 and 12 (also No. 8, as indicated by its Ph value and dextrose/KNO_3 ratio). This may be due to the conversion of the surplus sugar to organic acids (Klotz, *14*). The Ph value of the solution remains higher when the dextrose is exhausted before the nitrate in cultures Nos. 1, 2, 6, 7, and 10 (also Nos. 3 and 14, as indicated by their Ph values and dextrose/KNO_3 ratios).

Table X shows, for each culture solution, the amount of sugar consumed in grams per gram of fungus dry weight produced at the end of 11-, 28-, 41-, 54-day growing periods. From the variation in amount of sugar consumed per gram of fungus dry weight produced in the different culture solutions it appears that either the carbon of the strychnine is assimilated along with the dextrose to a greater extent in some solutions than in others, or that the sugar is more efficiently utilized in the production of fungus dry weight in some cases than in others.

Table XI shows the amount of potassium nitrate consumed in the production of one gram of fungus dry weight for several culture solutions. The variation in amount would indicate that the nitrate was reinforced to a greater extent with strychnine-nitrogen in some solutions than in others or that it was more efficiently utilized in the production of dry weight in some cases than in others.

Figure 3 shows in graphical form: the percentages of potassium nitrate, dextrose, and strychnine sulphate; the maximum amount of fungus dry weight produced; and the average rate of growth in milligrams per day for each of the fifteen different culture solutions.

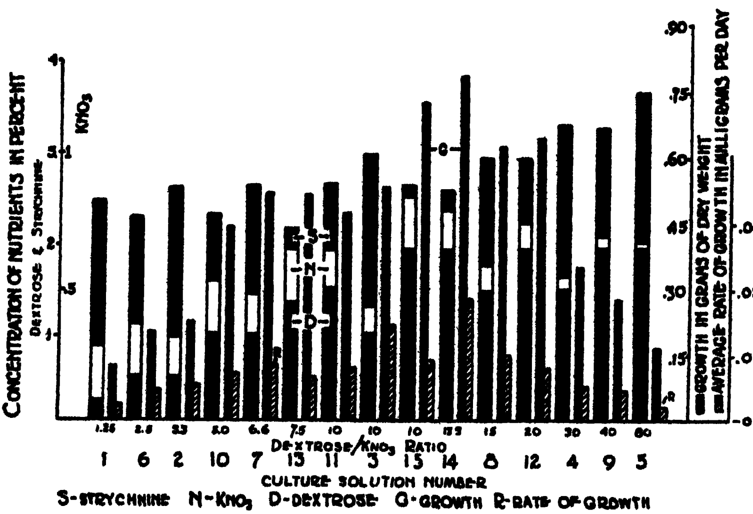


FIGURE 5: GRAPH COMPARING AMOUNT OF GROWTH AND COMPOSITION OF NUTRIENT SOLUTIONS

The numbers symbolizing the different culture solutions are the same as those used in the previous figure and tables, and are given in the lower row of figures below the graph. The ratios of dextrose to potassium nitrate in the different culture solutions are given in the upper row of figures below the graph.

The graph shows at a glance that there is but little if any correlation between the amount of growth and the concentration of strychnine sulphate. The amount of growth shows a close correlation with the dextrose concentration when the dextrose/KNO_3 ratio is below 13 and a close correlation with the KNO_3 concentration when the dextrose/KNO_3 ratio is above 13. In the latter case the resulting H-ion concentration of the culture solution is comparatively high as compared with the former, table IX. This acidity may be due to the conversion of the surplus sugar to organic acids (Klotz, *14*).

A more careful analysis of the graph shows that equal quantities of dextrose in cultures Nos. 6 and 2 did not produce equal amounts of fungus dry weight although dextrose was a limiting factor in growth. This was also true of cultures Nos. 10, 7 and 3, which contained equal amounts of dextrose. The greatest growth occurred in the solution with a dextrose/KNO_3 ratio nearer the optimum value of 13.3. This is also true of potassium nitrate when it is a limiting factor: cultures Nos. 9 and 4; and 8 and 12. In the latter two solutions the smaller amount of growth was obtained in solution No. 8,

in which the dextrose/KNO_3 ratio was closer to the optimum value of 13.3. This may be due to two limiting factors in solution No. 8, KNO_3 then dextrose, and only one limiting factor, KNO_3, in solution No. 12. Analysis of solution No. 8 showed that the KNO_3 and dextrose disappeared at approximately the same time, table VIII. That the KNO_3 disappeared before the dextrose was shown by the resulting H-ion concentration of the culture solution, table IX. Solution No. 12 had a greater amount of dextrose than solution No. 8. After the disappearance of the KNO_3, the fungus may have utilized the strychnine-nitrogen and continued to assimilate the surplus dextrose as was shown by a gradual increase in dry weight, table VIII and figure III.

TABLE VIII

Amount of growth in grams of dry weight produced in each of the 15 different culture solutions

Days	11	28	41	54
CULTURE NUMBER.	Weight in grams.	Weight in grams.	Weight in grams.	Weight in grams.
1	.1062	.1248	.1092	...
2	.1602	.2278	.1866	.1919
3	0962	5370	.4786	.3928
4	1838	3020	3556	3010
5	1228	1432	.1508	.1648
6	1232	2080	1863	.1734
7	1290	3656	.5245	.4294
8	2320	5018	.6318	.5567
9	2956	2952	3095	3057
10	1539	3828	.4440	.3790
11	3175	.4308	4780	.4669
12	1018	6230	.6316	.6476
13	2566	4490	.4972	.5206
14	.5082	.7938	.7207	.7423
15	3968	4688	.7146	.7345

TABLE IX

Hydrogen ion concentration of culture solutions taken at the end of the growing period

Days	11	28	41	54
CULTURE NUMBER.	Ph value.	Ph value.	Ph value.	Ph value.
1	2.95	2.90	2.87	....
2	2.75	2.35	2.30	2.70
3	2.60	2.20	2.00	2.40
4	2.50	1.90	*	*
5	2.45	1.90	*	*
6	2 50	2.37	2.28	2.30
7	2 64	2 20	2.28	2.38
8	2.45	1.90	*	*
9	2.20	*	*	*
10	2.55	2.37	2.63	2.68
11	2.40	2 37	2 55	2.50
12	2.65	2 20	*	*
13	2 40	2.30	2.64	2.60
14	2 20	2.20	2 00	2.00
15	2 40	2.48	2.00	2.20

* Ph too low to measure with potentiometer employed.

TABLE X

Dextrose consumed in grams per gram of fungus dry weight produced

Days	11	28	41	54
CULTURE NUMBER.	Grams of dextrose.	Grams of dextrose.	Grams of dextrose.	Grams of dextrose.
1	3.53	3.02	3.43	....
2	2.72	3.25	4.02	3.91
3	2.90	2.48	3.13	3.82
4	3.07	3.82	3.93	4.74
5	0.99	5.27	5.44	6.83
6	2.87	3.61	4.03	4.33
7	2.41	2.99	2.86	3.49
8	2 79	3.50	3.56	4.04
9	2.64	4.32	4.28	5 13
10	2.80	3 00	3.38	3.96
11	2 82	3.20	3.11	4.11
12	2.67	3.03	3.84	4.38
13	2.83	3.23	3.38	4.32
14	2.74	3.44	4.16	4.04
15	2.51	2.94	3.63	3.84

TABLE XI.—Potassium nitrate consumed, in grams, per gram of fungus dry weight produced

Culture solution number	Grams of KNO_3	Culture solution number	Grams of KNO_3
3	.279	9	.242
4	.210	12	.231
5	.227	14	.283
8	.237		

QUANTITATIVE EXPERIMENT ON STRYCHNINE ASSIMILATION

MATERIAL AND METHOD

This experiment was undertaken to determine the amount of strychnine removed by *Aspergillus niger* from culture solutions with varying dextrose/potassium nitrate ratios.

The composition of the different culture solutions in percent and their respective dextrose/potassium nitrate ratios are as follows:

Solution Number	4	9	14	19	24
Sugar/KNO_3 ratio	4	9	14	19	24
Dextrose percent	0.572	1.287	2.002	2.002	2.002
KNO_3 percent	0 143	0.143	0.143	0.105	0.083
Strychnine percent	1.047	1.047	1 047	1.047	1.047
$MgSO_4$ percent	0.123	0.123	0.123	0.123	0.123
KH_2PO_4 percent	0.272	0.272	0.272	0.272	0 272

A control series with the above composition minus the strychnine was run at the same time.

The culture solutions were made up in 1,800 c.c. amounts from stock solutions.

All of the culture solutions showed a H-ion concentration of pH 4.33.

The culture solutions were measured out in 75 c.c. portions into 125 c.c. Erlenmeyer flasks and plugged with cotton. The solutions were then sterilized and inoculated by the procedure used in the previous experiment.

A few cultures were subjected, from time to time, to Fehling's test for the presence of sugar and the test for the presence of nitrates described in the previous experiment. These cultures were later discarded. When the above tests indicated that either the dextrose or nitrate had completely disappeared from the culture solutions, the mycelium was removed, dried to constant weight, and weighed as described in the previous experiment. Three cultures were used

for each determination. The strychnine content of the culture solutions was then determined by the following procedure: the solution was made alkaline by the addition of ammonia, which precipitated the strychnine base in the form of crystals. This also precipitated a small amount of other substance from which the strychnine was separated by its solubility in chloroform. After standing overnight, the solutions were filtered through No. 589 filter paper manufactured by Carl Schleicher and Schüll, the crystals dried in a vacuum oven at 40 degrees centigrade, and weighed. The strychnine portion of the precipitate was then removed by running chloroform through the filter paper. The filter paper and insoluble residue was dried to constant weight and reweighed. The loss in weight represents the amount of strychnine in the culture solution.

The accuracy of the above method for the quantitative determination of strychnine was found by adding equal amounts of strychnine sulphate to 100 c.c. amounts of distilled water and to 100 c.c. amounts of different culture solutions in which the fungus had been growing. The amounts of strychnine recovered from the above solutions were as follows:

From distilled water:	From culture solutions:
.7846 gram	.7731 gram
.7809 gram	.7825 gram
.7851 gram	.7737 gram
.7827 gram	.7845 gram

This shows a maximum experimental error of less than 2 percent.

EXPERIMENTAL RESULTS

Qualitative tests for the presence of sugar and nitrate showed that the dextrose disappeared before the nitrate in solutions Nos. 4 and 9 and that the nitrate disappeared before the dextrose in the remainder. The relative time required in days for the complete disappearance of dextrose in solutions Nos. 4 and 9 and the disappearance of nitrate in solutions Nos. 14, 19, and 24 are as follows:

SOLUTION NUMBER.	Strychnine solution.	Control solution.
4	16 days	22 days
9	18 days	23 days
14	16 days	22 days
19	12 days	18 days
24	12 days	16 days

The amounts of fungus dry weight produced and strychnine assimilated in grams for each of the five different culture solutions are as follows:

Solution Number	4	9	14	19	24
Growth in strychnine solution	.3866	.6856	.8822	.8649	.7095
Growth in control solution	.2817	.5573	.8011	.7403	.6477
Percent increase in strychnine solution	37.20	23.00	10.10	16.80	9.50
Strychnine assimilated	.0000	.0000	.0360	.0036	.0000

The above data indicates a slight assimilation of strychnine in solutions Nos. 14 and 19, while no change could be detected in the strychnine content of the remaining solutions. The percentage increase in growth appears to be greater in the strychnine solutions with a low dextrose/KNO_3 ratio, which would indicate that the increase in growth is not due to the assimilation of strychnine-nitrogen. The results of these experiments indicate that strychnine has but very little, if any, nutritive value, its action being purely stimulative.

CONCLUSIONS

Strychnine sulphate acts to increase growth of *Rhizopus nigricans* and of *Aspergillus niger* in Coons nutrient solution and quinidine sulphate has a similar effect on the latter organism. Growth of both fungi is decreased by caffeine citrate, and that of *R. nigricans* by quinidine sulphate. These three chemicals also retard sporulation by *A. niger*. Since *A. niger* makes no use of the carbon and only slight use of the nitrogen contained in strychnine, increase in growth of this fungus is believed to be due to a stimulatory action resulting in efficient utilization of the carbon and nitrogen of the nutrient solution.

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The Flora of the Sand Hills of Harvey County, Kansas

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ABSTRACT: This study of the flora of the Harvey county, Kansas, sand hills was made during the years 1932, 1933 and 1934. Special attention was given to the factors which affected the plants, and the effect of the various plants and other factors upon the topography of this area. Plants of the various formations and the order in which they appear in these formations are noted. This covers the various stages in the development of blowouts and deposits, from their start until they reach their climax vegetation.

INTRODUCTION

IN a cursory survey of the plants of Harvey county, Kansas, the vegetation of the sand-hill area presented such a striking difference in appearance from the surrounding territory that it was deemed worth while to make a closer study of the causes for this wide difference in the vegetation, so obvious even to the casual observer. A search of the literature on this subject showed that the sand-hill flora had not received the deserved attention in this state. Other phases of plant life have attracted much wider attention than this problem, which has been subjected to much intensive study in other parts of the country. The study by Hitchcock (8), in his Ecological Plant Geography of Kansas, is all that is directly related to the problem.

The work by Cowles (5) on the Ecology of plants of the sand dunes of Indiana and Michigan; the works of Pond and Clements on the Phytogeography of Nebraska (11) and that by Rydberg (13) on the vegetation of the sand-hill regions in Nebraska; and finally, that by Gleason (7) on the vegetation of the inland sand deposits of Illinois, were further inducements to undertake a more intensive study of the ecological relationship of the plants of this section. The material presented in this paper is from observations made during the years of 1932, 1933, and 1934.

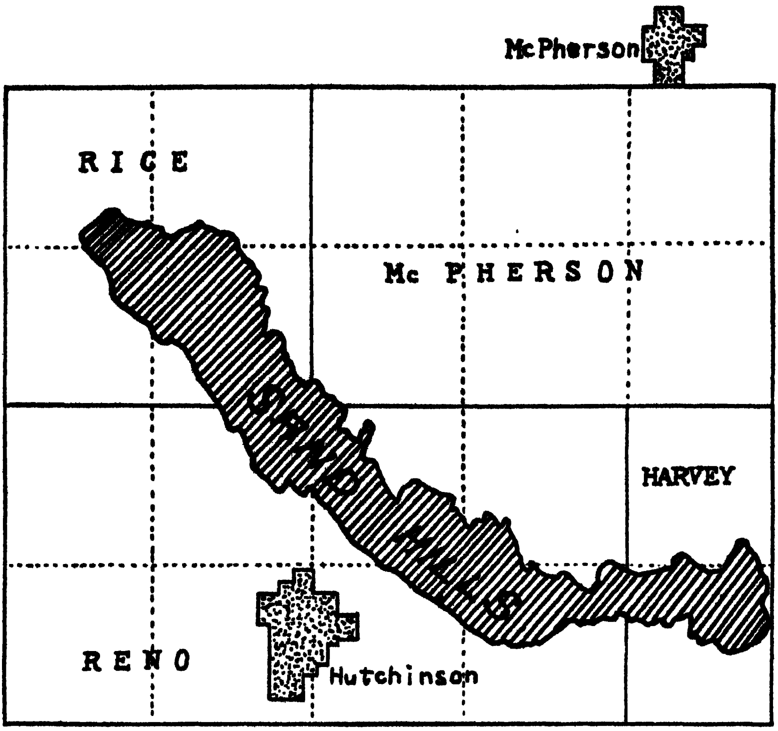

FIG. 1. Taken from The State Geological Survey of Kansas, 1896.

SOIL

The soil was identified by The University of Kansas Geological Survey of 1896 (9) as belonging to the Tertiary Equus beds. The sand is a surface residue due to erosion of this formation. There are other and much more extensive sand-covered areas running west and southwest across the state along the south side of the Arkansas river.

PHYSIOGRAPHY

The topography of the region is extremely level, with no elevations of any consideration, and gradually rises in the westerly direction, starting with an elevation of 1,454 feet at Newton and rising to 1,535 feet at Hutchinson, a distance of about forty miles. The section of most intensive study is about halfway between the two points, near the town of Burrton and some 1,492 feet in elevation above sea level.

CLIMATE

The climate is characterized by great extremes in wet and drought, heat and cold; and, due to the level, unbroken surface, in prevalence of periodic storms, some of which are of considerable duration.

The average annual precipitation and the distribution of the same by months as shown by the graph (fig. 2) is such that late summer plants are discouraged during their blossoming and fruiting

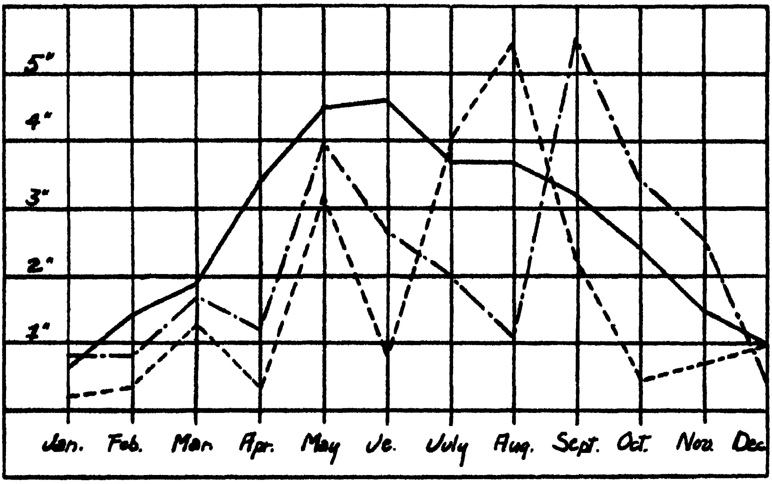

FIG. 2. Precipitation 1933, 1934,
Average precipitation 1897-1933, ——.

season. The graph also shows that the last two years of study have been abnormally dry for this region. This may account for a possible reduction in the number of species found.

The wind has an unbroken sweep, and blows from the south and southwest throughout the spring and sometimes into early summer.

The extremes of heat and cold are very great and, when accompanied by strong, dry winds, make conditions very difficult for plant life. Figure 3 shows the average monthly temperatures of Newton for the last thirty-seven years and the deviations from this average for the years 1933 and 1934.

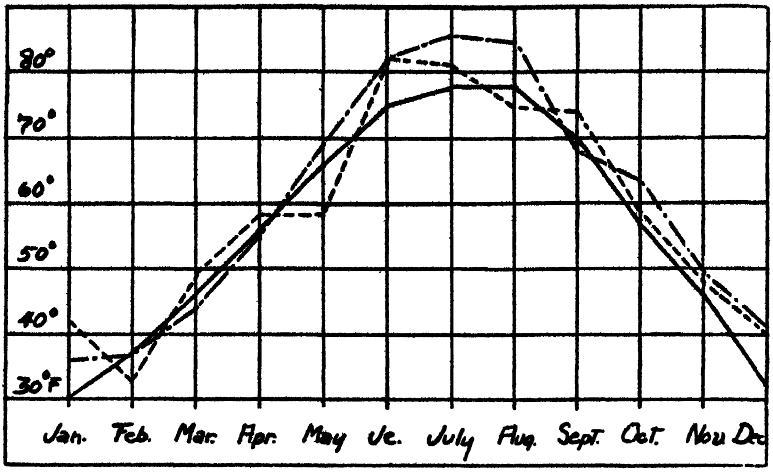

FIG. 3. Temperature 1933, ——; 1934, ——.
Average temperature 1897-1933, ——.

EDAPHIC FACTORS

The sand deposit is naturally the great and determining factor in the sand-hill flora and, therefore, was studied in some detail.

It is somewhat difficult to place the boundaries of this sand-hill area at some places; at other places there is a sharp demarcation.

There has been considerable shifting of the dunes in the memory of settlers in this region. Some dunes have moved north due to prevailing southerly winds until they are now several hundred yards away from their former position and in some places section roads have had to detour these piles of sand.

The depth of this sand layer varies from the edge, where it may be only a thin covering or intermingled with the subsoil, to the highest dunes which are estimated to be from thirty-five to forty feet high.

There are places at the bottom of blowouts, throughout the complex, where the sand has been swept away to the subsoil.

The sand is characterized by a very marked uniformity in size of particles. Table No. 1 shows the range of sizes of the sand particles making up these dunes.

TABLE 1

Size of sand as determined by standard soil sieves

	Number of screen.					
	20	40	60	80	100	
Size of mesh (in mm.)	.900 × .900	.375 × .375	.185 × .185	.175 × .175	.160 × .160	
Size of sand particles	.900 and up	.375 to .900	.185 to .375	.175 to .185	.160 to .175	.160 and less
Percent of soil retained by sieve	Trace	10	44.5	31.8	4.5	9.2

The No. 20 screen showed only a trace of particles too coarse to pass through the .9 mm. x .9 mm. mesh and only 9.2 percent that passed through the No. 100 screen.

TABLE 2

Comparative percolation rates of three soil types from this region

KIND OF SOIL.	Time percolation starts.	Water percolating in 15-minute periods (c c.).			
		First period.	Second period.	Third period.	Average.
Sand-hills sand	3 minutes	430	462	437	438
Garden loam	30 minutes	62.5	60	53.5	59
Sand-hills subsoil	4 hrs., 7.5 min.	1.5	1.2	1.2	1.3

The percolation test of the soil shows the relative permeability of this sand to water as compared with garden loam taken outside the dune region and the subsoil of the dune region. The brass cylinders used were 1 15/16" in diameter and the column of sand was 8.5" high. This test shows the soil of the dunes to be so permeable that no surface water drains off, even in the heaviest rains, but is all taken up by the sand where it falls, and passes down through the sand until it reaches the soil water level.

This table (No. 2) also shows the rather impervious character of the subsoil that underlies most of this sand-hill area. It is less than 0.3 percent as pervious to water as the overlying sand. This impervious property of the subsoil causes the formation of ponds where the sand is blown down to the subsoil. These ponds are quite numerous in wet seasons and some of them, in the deepest

blowouts, are so permanent that hydrophytic species are not uncommon in this otherwise typically arid area.

With the pervious condition of the sand and its low water-holding capacity in mind, due to the size of the sand particles, and largely to its lack of organic matter, the test for capillarity was applied (table No. 3). This shows that the sand can readily supply its

TABLE 3

Test for capillary rise of water in the soils (in centimeters)

TIME RUN.	Kinds of soil.		
	Sand-hills sand.	Garden loam for comparison.	Sand-hills subsoil.
5 minutes	6¼ cent.	2 cent.	1½ cent.
15 minutes	9½ cent.	3¼ cent.	2½ cent.
30 minutes	11¼ cent.	4¼ cent.	3½ cent.
45 minutes	12 cent.	5 cent.	4½ cent.
1 hour	12½ cent.	5¾ cent.	5½ cent.
2 hours	13½ cent.	7¾ cent.	6½ cent.
1 day	14½ cent.	13½ cent.	17½ cent.
2 days	14¼ cent.	14¾ cent.	22¾ cent.
3 days	14¾ cent.	15½ cent.	26 cent.
4 days	14¾ cent.	16 cent.	28 cent.
5 days	15 cent.	16¼ cent.	30 cent.

vegetation with sufficient water from the supply above the subsoil only after the plants are well rooted.

The sand is so fine and has so little binding material mixed with it, that it forms a loose mulch over the surface of the dunes whenever it dries. This helps to conserve the soil water against evaporation, and keeps the sand moist to within six inches of the surface even in the driest season, except in the places where dry sand is not being deposited by the wind. This feature greatly reduces the loss of water from the soil by evaporation.

HUMUS

The organic content of the sand, after thorough drying, averages only .51 percent by weight. The method used for determination of organic matter was that given by Braun-Blanquet (2) for soils with no lime and little clay. A sample of the sand was dried in a drying oven for three hours at 110° C., weighed and then heated to

white heat in a platinum crucible for one hour. The loss resulting from igniting the sand was used as a measure of the amount of organic matter present.

WATER-HOLDING CAPACITY OF SAND

The amount of water the sand is able to hold was determined by weighing and measuring the amount of laboratory dried sand required to fill a cylinder and then soaking the sand by immersing the cylinder in water for an hour. After draining until no more water would drip from the cylinder, the weight of the water held by the sand equalled 27 percent of the weight of the dry sand. This equals 38.5 percent of the volume of the sand. Sand dried to a constant weight, in the laboratory atmosphere, still held 0.1 percent water.

SOIL ACIDITY

The sand and the subsoil tested according to methods mentioned by Braum-Blanquet (2), using the Baily (1) hydrogen electrode, showed a slight acid reaction.

VEGETATION

The western part of Harvey county is in the region of change from the bluestem or tall-grass prairie to the short-grass, or buffalo-grass, prairie.

This change is not entirely abrupt and is best seen in the original, unbroken prairie that has been fenced and pastured. Severe pasturing seems to be one of the causes to bring about the change from bluestem to buffalo grass, for the prairie that was not broken and has been used for hay meadows is still of the tall-grass type, while the adjoining pastures are largely of the short-grass type except where the soil is loose, due to its sandy character. Few of the main short-grass species are found in loose sandy soils. The short-grass pastures are characterized by *Buchloe dactyloides* (Nutt.) Engelm., *Bouteloua oligostachya* (Nutt.) Torr., and *Bouteloua hirsuta* Lag. The first was never found in the sandy soil, and the latter two species only where the soil is clayey enough so as to pack quite hard. This alone could account for the absence of these grasses on the dunes.

There is little, if any, of the original undisturbed prairie left in this section of the state. Close pasturing has changed the vegetation to such an extent that if left to itself without pasturing for awhile

it has little resemblance to that which has been preserved for prairie hay meadows. In such places a large number of weeds now form the dominant vegetation. The following are the most numerous in such places: *Allium mutabile* Michx., *Rumex crispus* L., *Amaranthus retroflexus* L., *Baptisia bracteata* Gray, *Euphorbia marginata* Pursch., *Callirhoe digitata* Nutt., *Opuntia Rafinesquii* Engelm., *Oenothera biennis* L., *Apocynum cannabinum* L., *Verbena bracteosa* Michx., *V. stricta* Vent., *Solanum rostratum* Dunal., *Plantago major* L., *Vernonia fasiculata* Michx., *Ambrosia psilostachya* Gray, *Xanthium commune* Britton, *Achillea millefolium* L., *Cirsium lanceolatum* L. Hill, *Helianthus annuus* L., and *Taraxacum officinalis* Weber.

Even the unbroken hay meadows, through cropping, have changed so that the tall prairie grasses are hardly dominant at certain times of the year. *Psoralea digita* Nutt. (B&G), and *Amorpha canescens* Pursch., often obscure the grasses completely, from a distant view. Nevertheless this is the true prairie province with no natural timber or brush, except along the watercourses, and, to use Cowles' term, the tall grass association is the climax formation. Therefore we shall consider any approach to this climax condition as an indication that the sand-hill vegetation is becoming stabilized.

A considerable portion of the sand-hill marginal land is under cultivation. Here crops generally have to be planted late because of the shifting of the sand by the spring winds. Drifting sand often fills lister furrows and covers up corn in early July. These border fields do produce excellent watermelons and sweet potatoes, both being planted late in the season.

The region of most intensive study in this problem was seventeen miles west and about one and one half miles north of Newton, Kan. A main road passing through the sand hills at this point makes it quite accessible, and because of the shifting of the dunes, a space has been left unfenced to the side of the road. In places this is as much as a quarter of a mile wide. This area was not pastured and the vegetation was as little disturbed as any that could be found. This area contains dunes, level places, and blowouts in all stages of their development. Most of the plant specimens studied were taken from this area.

One of the striking features of this region is the number of species, and the abundance of some of these species, that are seen on the way to the sand hills, but are only rarely, or never, seen in the sand hills.

The surrounding pastures are generally full of *Vernonia fasiculata*, *Euphorbia marginata*, and *Poa pratensis* L., but in the sand hills

this species of Euphorbia was never observed, while the Vernonia and Poa were each seen once. Cultivated fields in the surrounding country are generally marked by *Helianthus annuus* L., but this species was not found in the cultivated fields of the sand hills. Instead we find *Helianthus petiolaris* Nutt.

The whole prairie region of this part of the state is marked by the absence of trees, except along the watercourses, and those that have been planted in other places. Shrubs are also lacking, except those that have found refuge under trees or in places bordering water bodies. The sand hills, in contrast with the surrounding treeless plains, are dotted with *Populus Sargentii* Dode and *Salix nigra* Marsh. An occasional *Catalpa sp.* and *Morus ruba* L. are also found. *Prunus angustifolis* Marsh., the sand-hill plum, often covers areas to the exclusion of other vegetation. This shrub sometimes covers as much as ten percent of a pasture. *Cephalanthus occidentalis L.* is the shrub of next importance and may be found as single shrubs, in clumps, or in thickets which may cover as much as fifteen square rods. This plant forms the densest cover of vegetation to be found in these dunes. *Cephalanthus occidentalis* is described in *Trees in Kansas* as "a swamp-type species found growing only in swampy locations or along the margins of streams where an abundance of soil moisture is available." In this area it is often found perched on dunes which are twenty feet in height. As a rule it is found along the low places and its presence on the tops of the dunes can be explained only by the fact that its growth rate is fast enough to keep its tops above the incoming sand. In this way its roots are in a perpetual water supply while its tops are exposed to very xerophytic conditions.

Salix tristis Ait., a dwarf willow, which does not exceed the medium grasses in height, is quite common. An occasional unidentified species of Rubus, *Rosa setigera* Michx., *Amorpha fragrans* Sweet, and *A. canescens* complete the list of shrubs commonly found growing in these sand hills.

A considerable portion of this sand-hill area is practically bare of vegetation because of the shifting sand which is blown back and forth as the wind shifts from south to north and back to the south again. Thus the plants which try to get established in the open places usually get covered by the drifting sand, or have the sand removed from around their roots. We may therefore assume that the sand hills which are now covered by vegetation were once piles of loose, drifting sand. This makes the successions of plants the most interesting ecological problem of this area. To answer this,

with any degree of accuracy, one should have accurate data from a considerable number of years. In a limited time the closest approach to this seems to be the study of the various dunes and blowouts which represent the various stages in their development.

Blowouts are numerous throughout this area and may be studied from their merest inception to their stabilized condition. They occur throughout the sand hills wherever the sand is deep enough so that the wind can undermine the roots of the existing vegetation. A blowout may be started along a cow path or any other place where the vegetation cover becomes broken enough for the wind to start moving the sand. When the sand is removed from the roots of the plants they die and topple over, leaving more sand exposed to the action of the wind. The sand so removed is carried until it is deposited around other plants which may be eventually

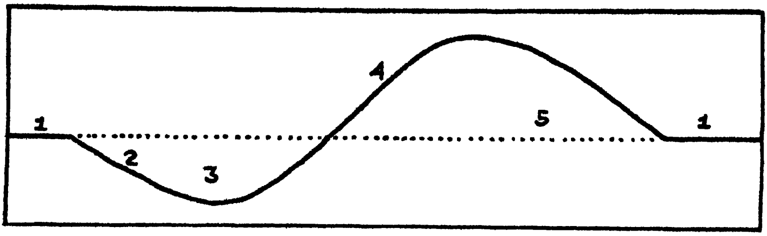

FIG. 4. Diagrammatic longitudinal section through a typical blowout; 1. Original level of the sand. 2. Windward slope. 3. Basin. 4. Lee slope. 5. Deposit.

buried by it. When once started, a blowout usually keeps on growing until the leeward dune breaks the wind until it can no longer carry sand fast enough to keep the plants out, or, until some plants which can establish themselves in such conditions come in and stop the movement of the sand.

The accompanying illustration, taken from Gleason (7), shows well the condition of the ordinary blowout.

In this region the spring winds are more destructive than the summer winds, for they are much stronger and the sand has the least in the way of protective vegetation. With the coming of warmer weather and more moisture, the sand which is not too actively moving is soon covered with vegetation. As the strong winds of spring and summer are from the south, most of the blowouts extend from the south to the north with the windward slope to the south. Some blowouts get started in the winter, by the north winds, and they head to the south. Plate XIII, figures 1, 2, and 3, are different views of the lee slope of a deposit at the south end of

blowout. The sand here has been brought in from the north. Figure 1 shows a portion of this slope which is covered by a thicket of Cephalanthus about four feet in height. This was taken in July, 1932. Figure 2, taken from a different angle, in March, 1933, shows the same plants after they had been buried to within one foot of their tops by the north winds of a snowless winter. Figure 3 shows the same spot from approximately the same angle as that from which figure 2 was taken, in May, 1933. In that short time the Cephalanthus had grown a foot in height and had the sand fairly well protected from the action of the wind.

The average blowout has its windward slope to the south. This slope is usually quite steep and has little vegetation. The plants found here are usually those which have been undercut by the winds and have slid down from the level sand above. A few summer annuals may come in on this slope. There is, however, little chance for seeds to become covered to a proper depth and get the right moisture conditions to insure their germination and the establishment of plants.

The bottom of an active blowout provides a more favorable place for the starting of new plants, but here one finds mostly late summer annuals. The seeds are carried in and covered by the less violent summer winds, and, with moisture conditions here more favorable the plants are able to get a start. Only the hardiest herbs are able to withstand the constant contact with the continously moving sand. The number of species found in such places are generally few, with *Cenchrus pauciflorus* Benth, *Diodia teres* Walt., and *Cristatella Jamesii* T. & G. being the one most commonly found. The last two are especially well fitted for such conditions. Diodia is entirely covered by coarse hairs which are little injured by the sand, while Cristatella is covered with sticky glandular hairs which soon become covered with a protective layer of sand.

The sides of the trough are usually the steepest parts of the active blowout. Here the wind-driven sand very rapidly cuts the banks and removes the sand from under the plants' roots. The sides are often undercut, as the vegetation which can succeed in the sand hills usually has a very extensive root system, which penetrates the loose sand to a great depth, thus holding the top soil until it is undercut. Surface plants which slide down from the top supply practically all of the vegetation found on these slopes. (Plate XIV, fig. 1.)

The lee slope of the blowout is less steep than either the windward slope or the sides of the trough and may be cut in the first stages of the formation, but it soon becomes inactive. This slope

serves as a highway for the sand in its transportation from the trough to the deposit. It, therefore, is a poor place for young plants to get started and so remains bare until summer, when the windy season is over. At this time the seeds that have been covered to a favorable depth germinate and the slope becomes sparsely covered by plants. A few perennial grasses may start and live through the following seasons, but the bulk of the vegetation is composed of summer annuals.

There may be deep-rooted plants of the previous cover surface of the lee slope, and there may also be plants on the face of the deposit slope that have been partially buried each spring and that come through the sand the following summer. In this way some slopes have perennial plants as a residue from a previous occupation. Plate XIV, fig. 2, taken July 4, shows an early summer condition, while Plate XIV, fig. 3, shows the same place on September 16. Aside from the few perennial grasses the plants are almost exclusively *Heliotropium convolvulaceum* Nutt. This plant is a summer annual. The seed generally germinates in June, and the seedlings are about two to three inches high in early July. They generally have to start under adverse conditions, for if a strong wind carries the dry sand over the surface with any great velocity the young plants are severely cut by it, and the intense light and heat on this southern slope are severe tests for young seedlings.

Temperature readings on June 8, 1933, at 2:30 p.m. showed as follows: on the south slope the surface sand was 142° F.; at five inches down it was 95° F.; and at ten inches down it was 86° F. At the same time the north slope of the deposit was as follows: surface sand, 126° F.; at five inches down, 95° F.; and at ten inches down, 86° F. At this time the Heliotropium seedlings were just getting a start and were mostly not over an inch high, with their lower leaves next to the hot sand; in fact, many of the leaves were in contact with the sand.

No attempt was made to measure the intensity of the light, but with the reflection from the light, buff-colored sand, it was very high. Camera exposures had to be cut down to one half normal to prevent overexposures.

The lee slope of the blowout and the deposit generally has a greater variety of plants than shown in Plate XIV, fig. 3. Species in the order of frequency could be arranged somewhat as follows: *Heliotropium convolvulaceum, Diodia teres, Cenchrus pauciflorus, Cristatella Jamesii, Froelichia floridana* (Nutt.) Moq., *Eragrostis*

pectinacea (Michx.) Steud., *Calamovilfa gigantea* (Nutt.) Scribn. & Merr., *Ambrosia philostachya.*

The north side of the deposit at the end of a blowout that is caused by a south wind is the region of greatest plant growth. Here the vegetation is protected somewhat against the south wind and the excessive heat and drought. The only adverse condition here is that the deposit may receive so much sand in a given time that the plants will be buried faster than they can grow. If a deposit starts around *Populus, Salix* or *Cephalanthus*, a dune of considerable height may be formed, as these plants can stand being covered up from the bottom, and their growth keeps pace with that of the dune. Plate XV, fig. 1, shows this condition in which cottonwoods form the main growth. A few annuals are present, but the perennial grasses make an especially luxuriant growth at the foot of this slope.

If the deposit reaches a considerable height and the trough is deepened in proportion, it reaches a stage where the blowout is checked by its own development, because the wind is checked and the sand cannot be carried over the deposit any longer. Thus the blowout has reached its natural limits and so becomes inactive and in the course of time is stabilized by the succession of plants that normally bring about the perennial grass cover of such loose sand areas.

This simple form of blowout is not the commonest form; for blowouts are constantly reaching into each other and this complicates their analysis.

There is a general tendency to form series of sand ridges from north to south. Many of these are from fifty to two hundred yards wide, and from a quarter of a mile to a mile in length. This is a complex of blowouts which are very difficult to analyze, yet they do not contain anything that is not analogous to a part of a simple blowout.

RECOVERY

We assume that the tall-grass, or bluestem, prairie association is the climax plant formation of all this region of the state of Kansas outside the sand hills, and if any part would be left undisturbed by cultivation, cropping or grazing it would finally revert to the original condition and that, therefore, any near approach to this condition could be considered as a stabilization in the sand-hill vegetation.

The abundance of trees and shrubs in the sand hills is due primarily to the fact that bare sand dunes serve, and have in the past served, as barriers against prairie fires.

The recovery of the loose, bare-sand areas by the tall, perennial grasses constitutes a series of changes and successions of plant formations.

1. THE BASIN ASSOCIATION

The floor or basin of the blowout is generally destitute of plants in a well-established stage of its formation, and generally remains very sparsely settled until the blowout has reached its natural limits. As stated above, there may be a few remnants of plants that have been carried in from the surrounding banks or even some that have weathered excavation, but generally it is practically bare of plants. (Plate XV, fig. 3.)

Plate XVI, fig. 1, shows a stage in recovery in which *Diodia teres*, *Cristatella Jamesii*, a few sedges, and some grasses, including *Eragrostis pectinaceae* and *Cenchrus pauciflorus*, form a very sparse covering.

In Plate XV, fig. 2, we have a stage in which young poplars growing from the roots of *Populus Sargentii* are the main plants. These young shoots come from roots of small trees on the sides of the blowouts and often run seventy-five feet or more just under the surface of the sand. A root may give off many shoots as it crosses the basin. It is interesting to note that Cowles (5) makes the observation that this does not happen in the Lake Michigan region with *Populus monilifera* Ait. and *P. balsamifera* Du Roi.

There are sometimes young poplars in these situations that come up from seed; however, for this to happen the blowout must be deep, and close to the clay subsoil, so that the basin will hold water long enough for the roots of these seedlings to penetrate the soil to perpetual moisture. This condition is not very common in these sand hills.

If there is no great excess of moisture the basin may become well wooded. (Plate XVI, fig. 2.) However, in a prolonged wet spell the basin is apt to fill with water and drown out the young trees; or the grasses and weeds become thick enough that if a fire sweeps through the dry vegetation it will kill most of the young trees and in that case the grasses that are not seriously hurt by fire become the dominant cover. The roots of these grasses will sod the soil and the dead leaves and stems add to the humus cover of the sand until there is a tall-grass prairie.

2. THE LEE SLOPE ASSOCIATION

The loose sand of the lee slope is a much more difficult place for most plants to gain a foothold. The best sand binder of all plants

in these sand hills undoubtedly is *Calamovilfa gigantea.* This grass produces enormous root stocks that grow many feet in length in the loose sand, and send up stems at intervals. These stems readily grow from six to seven feet in height and a quarter of an inch or more in diameter, with twelve to fifteen stem leaves, eighteen to thirty inches long, besides having a bunch of basal leaves. The root system is exceedingly well developed and reaches far into the wet sand of the deeper strata so that the grass grows well in the dryest, hottest weather. The stem and leaves of this grass are so hard that they stand the sand blasts, and will not decay in a year, thus holding the sand in which they grow and constantly collect the surface-blown sand. (Plate XVI, fig. 3.)

The success of *Calamovilfa gigantea* in coping with this loose, drifting sand depends largely upon the fast rate of growth of its underground rootstocks, its ability to recover from being buried by sand, it enormous root system, which supplies it with sufficient moisture in the dryest seasons, and its copious growth of hardy leaves and stem above the ground. This latter growth soon produces a cover over the sand and provides conditions of moisture and humus in which other plants can get a start and they in turn help hold the sand from further blowing.

Calamovilfa gigantea is confined to this loose-sand area entirely, and as the interstitial plants become numerous and sand well settled it invariably loses out.

Next to *Calamovilfa gigantea, Panicum virgatum* L. ranks as a sand binder though it is not a pioneer in the loose sand. Once started it is more efficient in sodding the sand than Calamovilfa, for it produces a denser root system, and will stay past the loose-sand stage and grow in well-sodded prairie. It produces a much denser growth than Calamovilfa, though it does not reach the height and coarseness of the former. (Plate XVII, figs. 1, 2.)

What can be called dune lee slope in the complex dunes composes a large part of the loose-sand area; and the plants found there depend largely upon the age or stability of the sand deposit. Besides the species mentioned there are a large number of other plants in this formation, of which the following species are the most characteristic: *Pasplum ciliatifolium* Michx., *Panicum virgatum. P. Scribnerianum* Nash., P. *lanuginosum* Ell., *P. praecocium* Hitchc. & Chase, *Setaria imberbis* R. & S., *Cyperus bushii* Britton, *C. Schweinzin* Torr., *C. filiculmis* Coult., *Cristatella Jamesii, Cassia chamaecrista* L., *Tephrosia virginiana* (L) Pers., *Lespedeza capitata* Michx., *Lechae villosa* Ell., *L. tenufolia* Michx., *L. intermedia*

Leggett., *Physalis virginiana* Mill., *Plantago Purshii* R. & S., *P. virginica* L., *Diodia teres, Ambrosia psilostachya, Xanthium commune* and *Helianthus petiolaris* Nutt.

3. THE DEPOSIT ASSOCIATION

In the simple blowout the deposit generally takes a fanlike form, due partly to the less intensity of the wind here, and partly due to the veering of the wind off the straight course. In the complex dunes the deposit is a rather irregular loose sand area, receiving fresh sand with every wind that carries sand. Even the side winds, which may partly fill the trough again, help spread the deposit sand over considerable area. Therefore the limits between deposit and sodded areas are poorly marked in most places.

Aside from the regular plant formation characteristic of the deposits, this is the region of ruderal species. Here many vagrant weed seeds, blown in from the outside, may get a start even if conditions are not favorable for fruiting and establishment of the species. However, many common weeds in the fields surrounding the sand hills have never been observed even in this area. In most cases the permanent grasses are encroaching from all sides and sodding over the loose sand, and if the blowout loses its activity the whole area will become covered with the vegetation of the settled sandhill prairie.

The most common weed species of the deposit are: *Croton glandulosus* L., *Cyloloma atriplicifolia* (Spreng.) Coult., *Mollugo verticillata* L., *Helianthus petiolaris, Froelichia gracilus* Moq., F. *floridana* Coult. & Nels., *Oxybaphus hirsutis* Sweet., *Apocynum cannabinum* L., *Verbena bracteosa, Solanum rostratum, Diodia teres, Ambrosia trifida* L., *A. psilostachya, Euphorbia geyeri* Engelm., *Sideranthus annuus* Rydb., *Salsola Kali* L., *Cristatella jamesii, Lepidium apetelum* Willd., *L. ruderale* L., *Physalis virginiana, Chenopodium album* L., *Amaranthus graecizans* L., *A. blitoides* Wats., *A. retroflexus, Lactica scariola* L., and *Solidago leptocephala* T. & G.

Of the annual grasses on the deposit the following are the most common: *Digitaria sanguinalis* (L.) Scop., *Festuca octoflora* Walt., *Hordeum pusillium* Nutt., *Bromus racemosus* L., *Cenchrus pauciflorus*, and *Seteria imberbis*. These annual grasses are followed by the perennial grasses, which are usually of the following species: *Calamovilfa gigantea, Eragrostis secundiflora* Pres., *Elymus virginicus* L., *Paspalum ciliatifolium, Panicum praecocius, Chloris verticillata* Nutt., *Triplasis purpurea* (Walt.) Chapm., *Aristida purpurascens* Poir., *Sporobolus canovirens* Nash., *Agrostis hyemalis* (Walt.) B. S. P.

4. THE PRAIRIE ASSOCIATION

The ultimate prairie association of the sand hills never reaches the climax prairie formation of the surrounding country, due to the characteristics of the sand that constitutes the sand hills. The sand is too loose to form the short-grass prairie of many of the surrounding pastures; while many of the grasses of the tall-grass prairie have not been found in the sand hills. Among these may be mentioned: *Boutelous curtipendula* (Michx.) Torr., *Agropyron Smithii* Rydb., *A. repens* (L.) Beauv., *Schendonnardus paniculatus* (Nutt.) Trelease., *Elymus virginicus* L. and *Tridens flavus* (L.) Hitchc.

The low, wet places of the sand hills are characterized by the following grasses: *Tripsacum dactyloides* L., *Andropogon virginicus* L. (Plate XVII, fig. 3), *Echinochloa crusgalli* (L.) Beauv., *Alopecurus geniculatus* L., *Sporobulus cryptandrus* (Torr.) Gray, *Spartinia michauxiana* Hitchc.

SAND BINDERS

The sand binders are of prime importance here, as elsewhere, in the stabilization of loose-sand drifts, for the duty of holding the sand rests upon them until the subsequent species can get started and cover the sand surface. The grasses readily hold the first place in this important work, as is shown by the observations in our locality and also in those of workers in other parts of the world.

Warming (*14*) names *Psamma arenaria* as the most important sand binder in the coastal regions of Denmark. Secondary sand binders, according to his observations in coastal regions, are three woody plants: *Hippophae rhamnoides*, *Salix repens* and *Empetrum nigrum*. In the inland dunes in Europe he names *Elymus arenaricus* as the most important of sand binders.

Braun-Blanquet (*2*) ranks two grasses, Agropyrum and Calamagrostis, as the most important sand binders for inland Europe; and *Aristida pungous* and *Euphorbia gouyoniana* as the chief sand binders in the North African deserts; while for the sea strand areas of Europe he places *Elymus europaeus*, *Ammophila arenaria*, and *Cyperus capitatus* in the order of importance.

Cowles (*5*) places *Ammophila arundinaceae* first as dune former and also as a sand binder; of less importance he classes *Agropyrum dasystachum*, *Elymus canadensis* and *Calamograstis longifolia*.

Hitchcock (*9*), in his article on "Reclaiming Sand Dunes," ranks *Ammophila arenaria* as first in both Europe and America; and as a

second he mentions *Elymus arenaria* as a sand binder along the sea coasts. For the interior dunes in Central Netherlands and Denmark he places *Calluna vulgaris,* a heath-forming shrub, as the chief plant in artificial sand binding.

Pond and Clements (*10*) give *Redfielda flexuosa* as the chief plant that finally controls the blowouts in the Nebraska sand hills by binding the loose sand in those blowouts. It is often associated with *Muhlenbergia pungens* as a secondary and aiding species.

Gleason (*7*) ranks *Rhus canadensis* as the most important sand binder and dune former in the inland sand deposits of Illinois, and *Panicum virgatum* as only slightly less efficient, and *Tephrosia virginiana* and *Ceanothus ovatus* as secondary in this respect.

From this paper of Gleason's one may judge that he has to deal with considerably less loose sand than is the case along the shore of Lake Michigan; and probably not the severe drought and storm that the Kansas sand hills are subjected to.

As mentioned before, *Calamovilfa gigantia* and *Panicum virgatum,* and especially the first-mentioned, are the first to become established in our loose sand before any other plants can gain a foothold. Along with the last-mentioned grasses there are the shrubs: Cephalanthus, Prunus, Salix, and the tree *Populus sargentii* that serve as dune formers even if they have little power of binding the sand with their roots. To these last should be added *Yucca glauca* Nutt., which, due to its clusters of evergreen leaves, makes an excellent windbreak (Plate XVIII, fig. 2, and Plate XVIII, fig. 1), and due to its enormous storage root system (plate XVIII, fig. 3) act to prevent the sand from blowing readily wherever it makes a dense growth.

CONCLUSIONS

1. The sand hills of Harvey, Reno and Rice counties are similar to other sand hills in Kansas, especially westward along the Arkansas river. They are characterized as typically inland deposits with a limited amount of sand. It is only prevailing winds from one direction that cause movement of the whole complex in a general direction.

2. The extremes in temperature, wind, moisture and light make conditions difficult for plant growth.

3. The vegetation is characteristically xerophytic. The grasses are the predominant plant cover both as to number of species and as to stand.

4. Best sand binder for this area is *Calamovilfa gigantia,* with

Panicum virgatum second in importance. The latter, however, is not able to establish itself in actively moving sand.

5. Trees in this area are able to survive because of the impervious nature of the subsoil and the fire barriers formed by the bare sand.

6. Trees and shrubs which succeed here are able to propagate themselves by underground parts. Seed propagation of woody plants is relatively unimportant.

7. *Yucca glauca* is important in holding the sand after it has been stabilized.

8. The sand hills present a true transition between the tall- and short-grass prairies, for some species of each formation invade the sand hills while other species never appear there. Thus the prairie climax of the sand hills is never that of the surrounding country.

ANNOTATED LIST OF SPECIES

PTERIDOPHYTA

Filicales

Marsileaceae

1. Marsilea vestita Hook. & Grev.

Equisetales

Eqisetaceae

1. Equisetum laevigatum A. Br.

SPERMATOPHYTA

Najadales

Alismaceae

1. Sagittaria latifolia Willd.
2. Sagittaria graminea Michx.

Graminales

Gramineae

1. Tripsacum dactyloides L.
2. Andropogon scoparius Michx.
3. Andropogon virginicus L.
4. Andropogon furcatus Muhl.
5. Sorghastrum nutans (L.) Nash.
6. Digitaria sanguinalis (L.) Scop.
7. Leptoloma cognatum (Schultes) Chase
8. Paspalum ciliatifolium Michx.
9. Panicum virgatum L.
10. Panicum huachucae Ashe.
11. Panicum lanuginosum Ell.
12. Panicum praecocius Hitchc. & Chase.
13. Panicum Scribnerianum Nash.
14. Echinochlea crusgalli (L.) Beauv.
15. Setaria imberbis R. & S.
16. Cenchrus pauciflorus Benth.
17. Stipa spartea Trin.
18. Aristida intermedia Scribn. & Ball.
19. Aristida purpurascens Poir.
20. Alopecurus geniculatus L.
21. Sporobolus clandestinus (Spreng.) Hitchc.
22. Sporobolus asper (Michx.) Kunth
23. Sporobolus cryptandrus (Torr.) Gray.
24. Agrostis hyemalis (Walt.) B. S. P.
25. Calamovilfa gigantea (Nutt.) Scribn. & Merr.
26. Sphenopholis obtusata (Michx.) Scribn.
27. Koeleria cristata (L.) Pers.
28. Spartina Michauxiana Hitchc.
29. Chloris verticillata Nutt.
30. Bouteloua oligostachya (Nutt.) Torr.
31. Bouteloua hirsuta Lag.
32. Triplasis purpurea (Walt.) Chapm.
33. Eragrostis megastachya (Koeler) Link.
34. Eragrostis trichodes (Nutt.) Nash
35. Eragrostis pectinacea (Michx.) Steud.
36. Eragrostis secundiflora Presl.
37. Poa pratensis L.
38. Festuca octoflora Walt.
39. Bromus racemosus L.
40. Hordeum jubatum L.
41. Hordeum pusillum Nutt.
42. Elymus virginicus L.
43. Elymus robustus Scribn. & J. C. Sm.
44. Elymus striatus Willd.

Cyperaceae

1. Cyperus inflexus Muhl.
2. Cyperus Schweinitzii Torr.
3. Cyperus Bushii Britton.
4. Cyperus strigosus L.
5. Eleocharis palustris (L.) R. & S.
6. Eleocharis acicularis (L.) R. & S.
7. Fimbristylis autumnalis (L.) R. & S.
8. Scirpus validus Vahl.
9. Scirpus lineatus Michx.
10. Hemicarpha micrantha (Vahl.) Britton
11. Carex pennsylvanica Lam.

ANNOTATED LIST OF SPECIES—*Continued*

Xyridales

Commelinaceae

1. Tradescantia reflexa Raf.
2. Commelina virginica L.

Liliales

Juncaceae

1. Juncus tenuis Willd.

Liliaceae

1. Allium mutabile Michx.
2. Yucca glauca Nutt.

Amaryllidaceae

1. Hypoxis hirsuta (L.) Coville.

Iridaceae

1. Sisyrinchium albidum Raf.

Orchidales

Orchidaceae

1. Ibidium cernuum (L.) House.

Salicales

Salicaceae

1. Salix nigra Marsh.
2. Salix tristis Ait.
3. Populus Sargentii Dode.

Urticales

Urticaceae

1. Morus rubra L.

Polygonales

Polygonaceae

1. Eriogonum annuum Nutt.
2. Rumex altissimus Wood.
3. Polygonum aviculare L.
4. Polygonum ramosissimum Michx.
5. Polygonum Muhlenbergii (Meisn.) Wats.
6. Polygonum pennsylvanicum L.
7. Polygonum Persicaria L.
8. Polygonum hydropiperoides Michx.

Chenopodiales

Chenopodiaceae

1. Cycloloma atriplicifolium (Spreng.) Coult.
2. Chenopodium albun L.
3. Corispermum hyssopifolium L.
4. Salsola Kali L.

Amaranthaceae

1. Amaranthus retroflexus L.
2. Amaranthus graecizans L.
3. Amaranthus blitoides Wats.
4. Froelichia floridana (Nutt.) Moq.
5. Froelichia gracilis Moq.

Nyctaginaceae

1. Oxybaphus hirsutus (Pursh.) Sweet.

Aizoaceae

1. Mollugo verticillata L.

Caryophyllales

Portulacaceae

1. Talinum rugospermum Holzinger.
2. Portulaca oleracea L.
3. Portulaca pilosa L.

Ranunculales

Ranunculaceae

1. Anemone caroliniana Walt.
2. Delphinium virescens Nutt.

Papaverales

Papaveraceae

1. Argemone intermedia Sweet.

Cruciferae

1. Lepidium apetalum Willd.
2. Lepidium ruderale L.
3. Sisymbrium canescens Nutt.
4. Arabis virginica (L.) Trel.

Capparidaceae

1. Cristatella Jamesii T. & G.

Rosales

Rosaceae

1. Rosa setigera Michx.
2. Rubus sp.
3. Prunus angustifolia Marsh.

Leguminosae

1. Schrankia uncinata Willd.
2. Cassia Chamaecrista L.
3. Baptisia bracteata (Muhl.) Ell.
4. Baptisia australis (L.) R. Br.
5. Crotalaria sagittalis L.
6. Melilotus alba Desr.
7. Hosackia americana (Nutt.) Piper
8. Psoralea tenuiflora Pursh.
9. Psoralea digitata Nutt.
10. Amorpha canescens Pursh.
11. Amorpha fragrans Sweet.
12. Petalostemum villosum Nutt.
13. Petalostemum candidum Michx.
14. Tephrosia virginiana (L.) Pers.
15. Desmodium illinoense Gray.
16. Lespedesa capitata Michx.
17. Strophostyles pauciflora (Benth.) Wats

Geraniales

Linaceae

1. Linum floridanum (Planch.) Trel.

ANNOTATED LIST OF SPECIES—*Continued*

Oxalidaceae
1. Oxalis violacea L.
2. Oxalis stricta L.

Geraniaceae
1. Geranium carolinianum L.

Zygophyllaceae
1. Tribulus terrestris L.

Polygalaceae
1. Polygala sanguinea L.
2. Polygala verticillata L.

Euphorbiaceae
1. Croton glandulosus L.
2. Euphorbia Geyeri Engelm.
3. Euphorbia marginata Pursh.

Malvales
Malvaceae
1. Callirhoë digitata Nutt.

Violales
Cistaceae
1. Crocanthemum majus (L.) Britt.
2. Lechea intermedia Leggett.
3. Lechea villosa Ell.
4. Lechea tenuifolia Michx.

Violaceae
1. Viola Rafinesquii Greene.

Opuntiales
Cactaceae
1. Opuntia Rafinesquii Engelm.

Myrtales
Lythraceae
1. Ammannia coccinea Rottb.
2. Lythrum alatum Pursh.

Onagraceae
1. Ludvigia alternifolia L.
2. Ludvigia palustris (L.) Ell.
3. Oenothera rhombipetala Nutt.
4. Oenothera humifusa Nutt.
5. Oenothera laciniata Hill.
6. Oenothera serrulate Nutt.

Gentianales
Apocynaceae
1. Apocynum cannabinum L.

Asclepiadaceae
1. Asclepias tuberosa L.
2. Asclepias amplexicalis Sm.
3. Asclepias verticillata L.
4. Acerates angustifolia (Nutt.) Dec.

Polemoniales
Boraginaceae
1. Heliotropium convolvulaceum Nutt.
2. Lithospermum Gmelini (Michx.) Hitchc.
3. Lithospermum angustifolium Michx.

Verbenaceae
1. Verbena hastata L.
2. Verbena stricta Vent.
3. Verbena bracteosa Michx.

Labiatae
1. Salvia azurea Lam.
2. Salvia lanceaefolia Poir.
3. Hedeoma hispida Pursh.

Solanaceae
1. Solanum nigrum L.
2. Solanum rostratum Dunal.
3. Physalis heterophylla Nees.
4. Physalis virginiana Mill.
5. Datura Tatula L.

Scrophulariaceae
1. Linaria canadensis (L.) Dumont.
2. Penstemon Buckleyi Pennell.
3. Veronica peregrina L.
4. Gerardia paupercula (Gray) Britton.

Acanthaceae
1. Ruellia ciliosa Pursh.

Plantaginales
Plantaginaceae
1. Plantago Purshii R. & S.
2. Plantago virginica L.

Rubiales
Rubiaceae
1. Galium Aparine L.
2. Diodia teres Walt.
3. Cephalanthus occidentalis L.

Campanulales
Cucurbitaceae
1. Cucurbita foetidissima H. B. K.

Compositae
1. Vernonia fasciculata Michx.
2. Liatris squarrosa Willd.
3. Liatris punctata Hook.
4. Liatris spicata (L) Willd
5. Liatris kansana (Britton) Rydb.
6. Sideranthus annuus Rydb.
7. Solidago nemoralis Ait.
8. Solidago leptocephala T. & G.
9. Aster multiflorus Ait.

ANNOTATED LIST OF SPECIES—*Concluded*

10. Erigeron annuus (L.) Pers.
11. Erigeron canadensis L.
12. Antennaria neodioica Greene
13. Gnaphalium polycephalum Michx.
14. Ambrosia trifida L.
15. Ambrosia psilostachya Gray.
16. Xanthium commune Britton.
17. Lepachys columnaris (Sims) T. & G.
18. Helianthus petiolaris Nutt.
19. Helianthus Maximiliani Schrad.
20. Helianthus subrhomboideus Rydb.
21. Coreopsis tinctoria Nutt.
22. Bidens involucrata (Nutt.) Britton.
23. Gaillardia lutea Greene.
24. Achillea Millefolium L.
25. Artemisia ludoviciana Nutt.
26. Cirsium lanceolatum (L.) Hill.
27. Lactuca scariola L.
28. Pyrrhopappus grandiflorus Nutt.

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PLATE XIII

FIG. 1. A lee slope of a deposit with *Cephalanthus occidentalis* about four feet high. Taken July, 1932.

FIG. 2. The same as above, taken from a different angle, after three feet of sand has been deposited by the north winter winds. Taken March, 1933.

FIG. 3. The same as above, taken in May, 1933.

PLATE XIII

PLATE XIV

FIG. 1. A steep side bank of a blowout.

FIG. 2. The lee slope of a blowout, taken July 4.

FIG. 3. Another view of the same slope, taken Sept. 16.

PLATE XIV

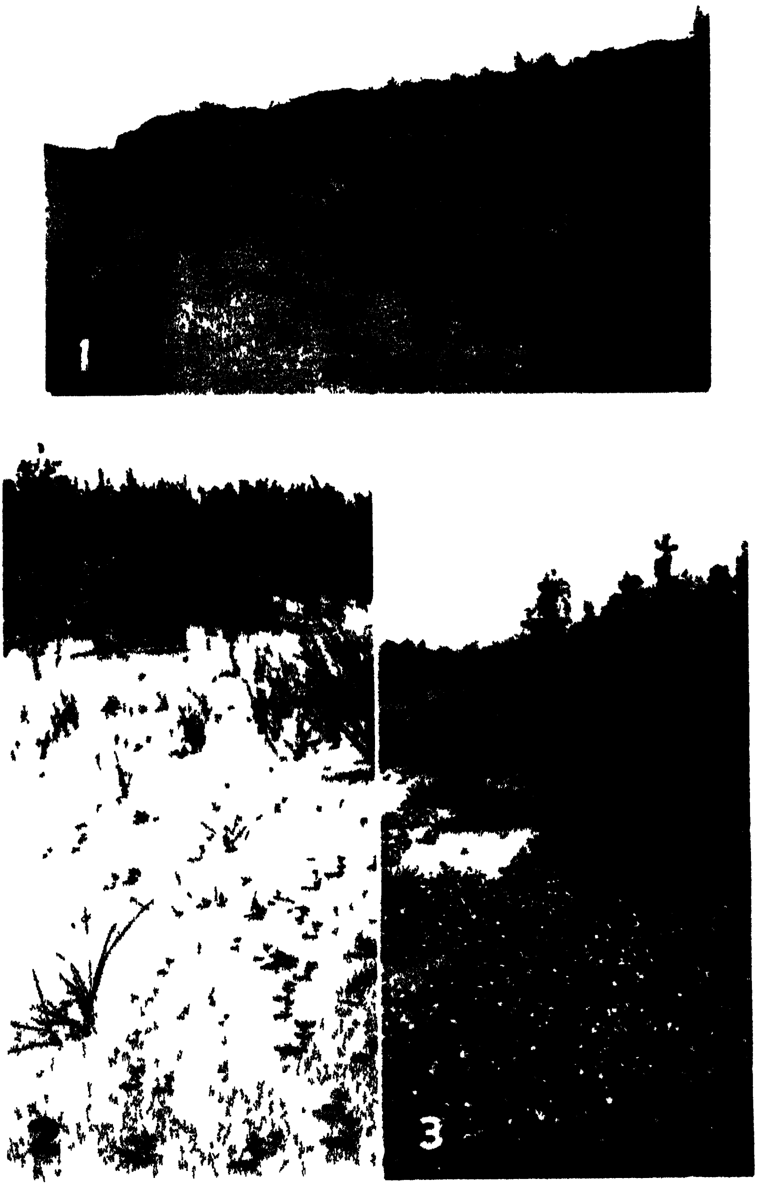


PLATE XV

FIG. 1. A lee slope of the deposit.

FIG. 2. A basin with *Populus Sargentii*, starting from long lateral roots which are just beneath the surface of the sand.

FIG. 3. A basin with very few plants.

PLATE XV

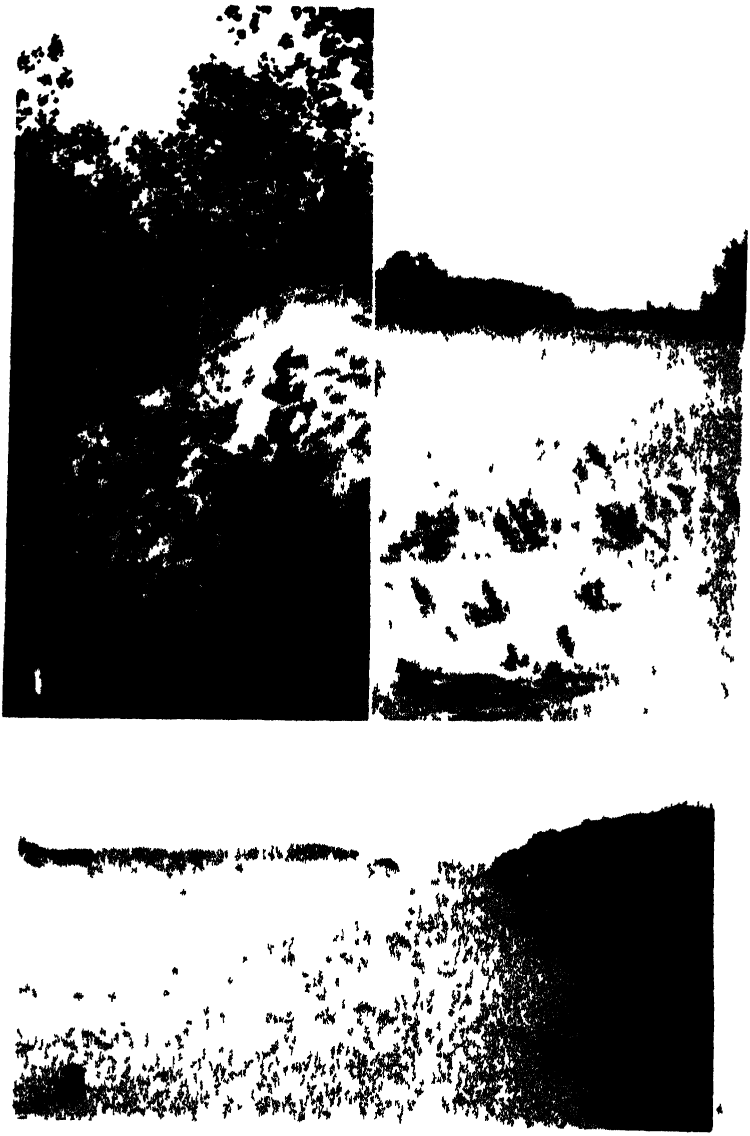


PLATE XVI

FIG. 1. A basin becoming well covered by vegetation.

FIG. 2. A basin well wooded.

FIG. 3. *Calamovilfa gigantea* as a sand binder.

PLATE XVI

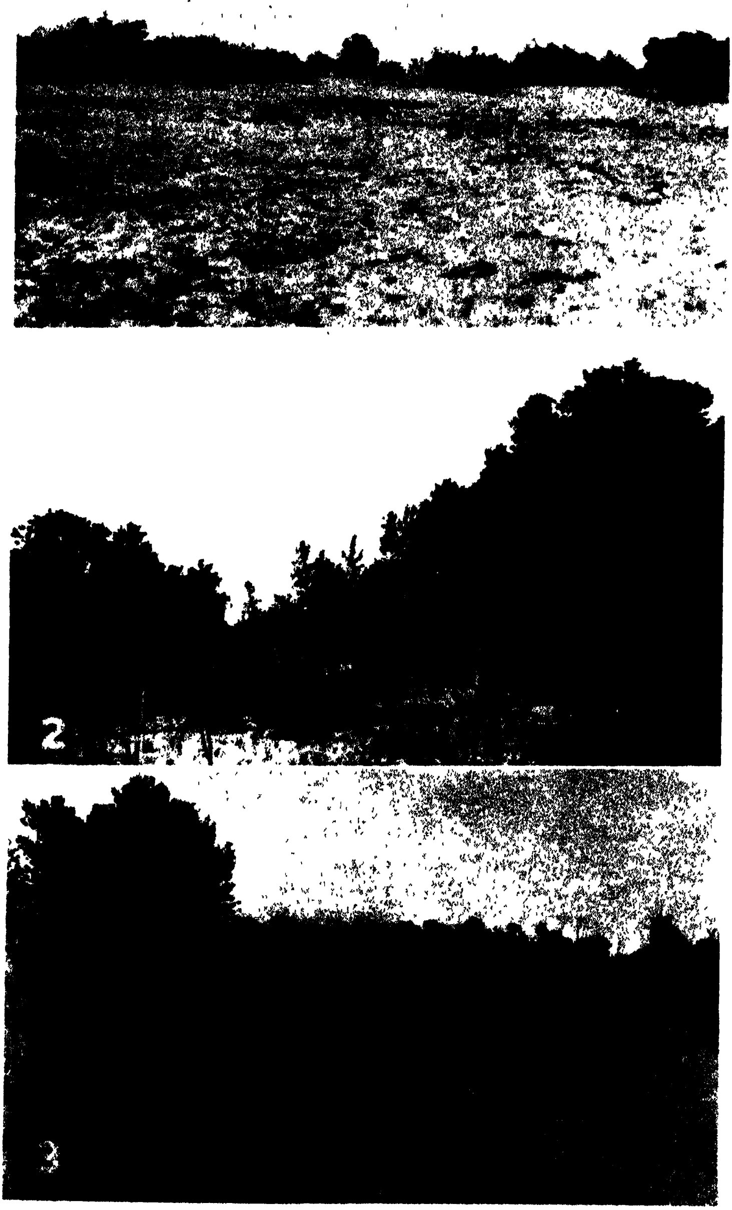


PLATE XVII

FIG. 1. *Panicum virgatum* developing a heavy surface cover.

FIG. 2. A *Panicum virgatum* mat being undercut.

FIG. 3. *Andropogon virginicus* in a low spot.

PLATE XVII

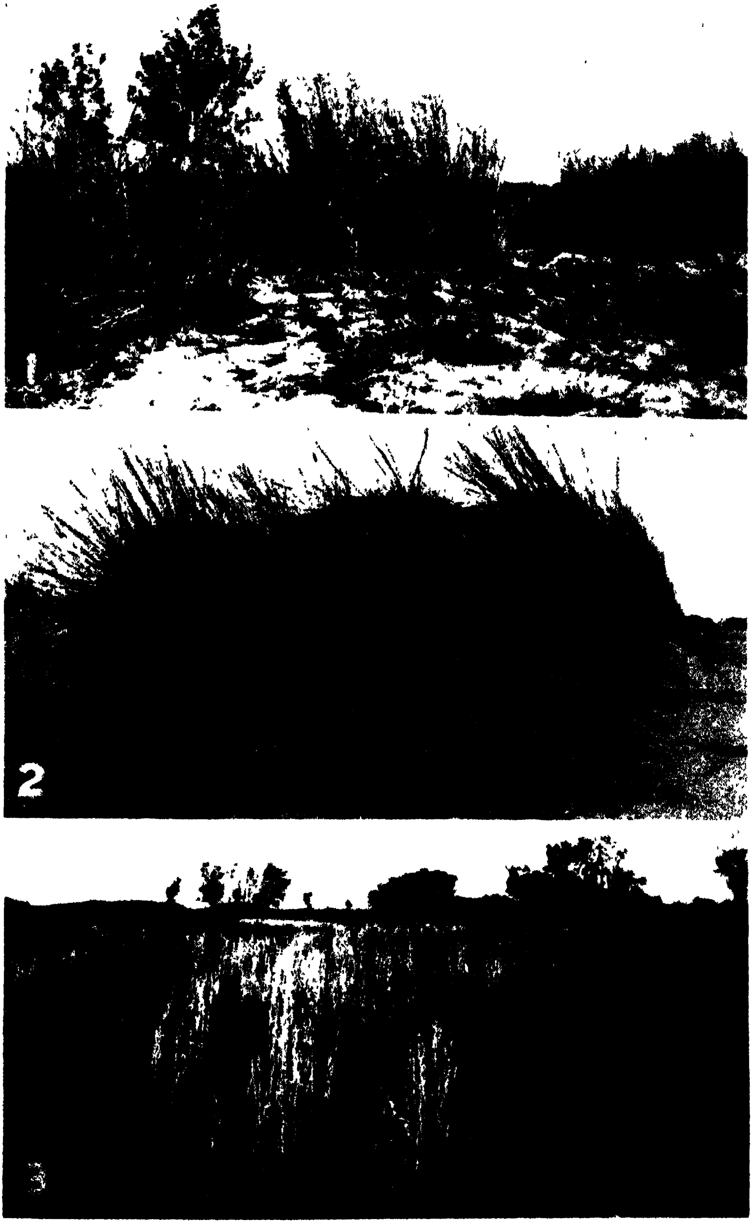


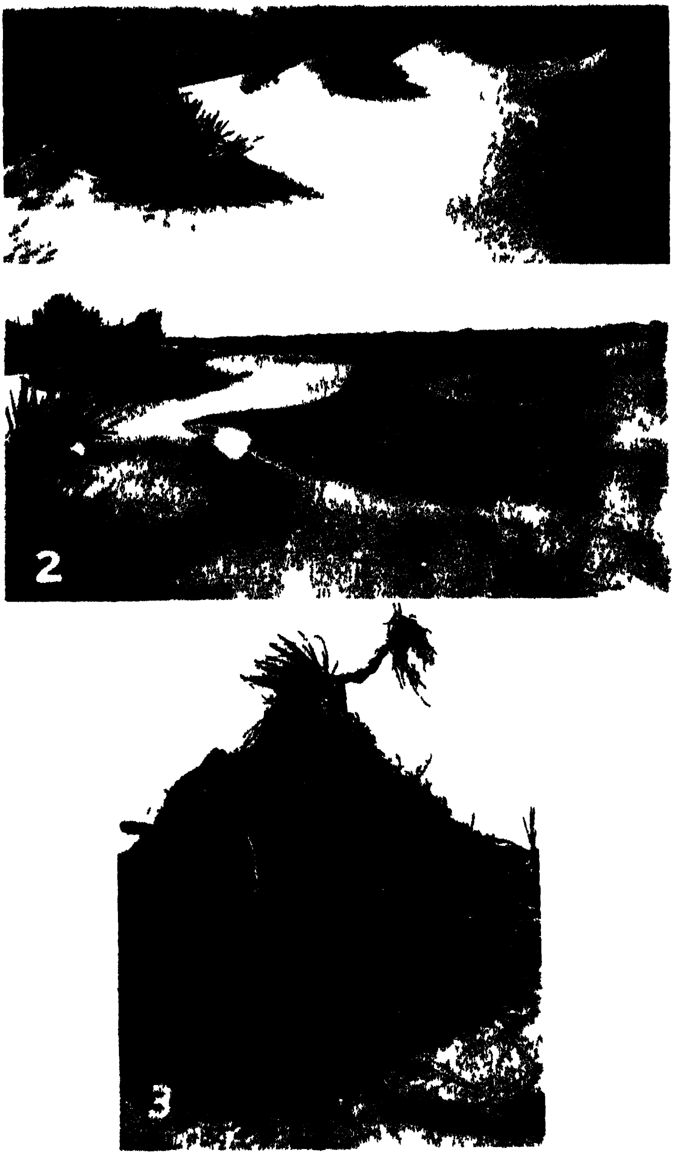
PLATE XVIII

FIG. 1. *Yucca glauca* stopping sand.

FIG. 2. The beginning of a deposit with *Yucca glauca* acting as a windbreak. *Yucca glauca* roots in the background.

FIG. 3. *Yucca glauca* being undércut with the enormous storage roots exposed.

PLATE XVIII



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Studies in Anaphylaxis XVI: Physiological Studies of Histamine and Peptone Reactions in the Cat

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ABSTRACT: The author reports the results of his physiological studies of histamine and peptone shock in cats. He obtained satisfactory results with both sodium amytal and ether anesthesia. The typical reaction in the cat to a single, rapid intravenous injection of either histamine or peptone was a three-phase drop in blood pressure. The maximum recovery time following histamine injection was 26 minutes, while in no instance was there a complete recovery of blood pressure following peptone shock. Histamine effects varied from a slight decrease to a definite acceleration of the heart rate, while peptone produced either a moderate or extreme slowing of the rate. Histamine caused a fleeting increase in kidney volume, while peptone produced a marked decrease. Likewise histamine caused a definite increase in intestinal pressure, while in peptone shock there was a loss of muscular rhythm and a relaxation of muscle tone observed in most of the experiments. The intracystic pressure was either unaffected or increased in both histamine and peptone shock. The coagulation time of the blood was unaffected by histamine and prolonged only slightly by peptone. A definite effect of narcosis was observed following histamine injection.

SECTION I—HISTAMINE

DALE and Laidlaw (*1*) in 1910 described the symptoms of histamine shock of the intact animal of several species. They found in the anesthetized cat that injection of 0.25 mgm. histamine per kg. body weight produced a slowing of the heart, which did not act directly on the heart muscle. The pulmonary pressure was increased due to arteriole constriction, while the systemic blood pressure was decreased. The limb volume and intestinal loop volume increased as the systemic blood pressure fell. The kidney and spleen exhibited a marked decrease in volume. Excised gastric and intestinal strips responded with contraction in the presence of high

dilutions of histamine. The body temperature was not materially reduced nor was the blood coagulation time prolonged. Dale and Richards (*2*) and others (*3, 4, 5, 6*) have contributed to our knowledge of histamine shock. Feldberg (*7*), Smith (*8*) and Bally (*9*) have conducted investigations of histamine shock in the rabbit. The action of histamine as summed up by Wells (*10*) is, "It causes bronchial spasm in guinea pigs, obstruction to pulmonary circulation in rabbits and a fall of blood pressure in dogs. It causes marked local urticaria of the skin in humans, and it does all these things in extremely minute doses."

With this data in mind it seemed of value to verify the physiological responses to histamine injection, and to add to the knowledge of the responses to peptone injection in the cat, thus to compare them with the physiological responses of feline anaphylaxis.

EXPERIMENTAL

This series included six normal, healthy cats, which varied in weight from 2,200 to 4,000 grams. The average weight was 2,830 grams. Four of the animals were females and two were males. The various physiological experiments were performed simultaneously on each of the cats except in the first few the technique of recording changes in kidney volume was not perfected.

Anesthesia: The animals of this series were given intravenously 55 mgm. sodium amytal per kilogram, for three of which the anesthesia was incomplete, so the trachea was cannulated and an ether bottle attached.

Injections: All injections were made by means of a cannula tied into the right femoral vein. Each histamine injection was followed by five c.c. of warm Ringer's to wash the cannula free of histamine and insure us that the entire injection had reached the circulation.

The technique employed was essentially that described by Bally (*9*).

RESULTS

The responses of blood pressure, coagulation time and rectal temperature recorded in this study confirm those reported by Dale and Laidlaw. Twenty-five hundredths (0.25) mgm. of histamine, when injected intravenously, produced an average drop in blood pressure of

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NOTE.—Studies in Anaphylaxis XVI and XVII belong to a series of investigations of anaphylaxis being directed or conducted by N. P. Sherwood and O. O. Stoland of the University of Kansas.

56.9 percent. Subsequent to 67 percent of the histamine injections the blood pressure curve followed that described by Dale and Laidlaw as the "three-phase drop." The time required for the blood pressure to recover was 7.5, 17, 20, 20, and 26 minutes, respectively, in the five animals that survived the initial injection of histamine. The recovery time progressively shortened with succeeding injections. There was no apparent difference in the physiological responses when under amytal from those of ether anesthesia.

Heart rate: Five of the six cats survived the first injection of histamine. The heart rate was unchanged in two, decreased by 15 beats in one, and increased by 5 and 77 beats, respectively, in two.

Kidney volume: In our experiments a fleeting but definite increase in volume was observed. The increase was immediately replaced by a marked decrease in volume as the blood pressure fell.

Intestinal pressure: A definite increase of intestinal pressure followed every injection of histamine. The increase in pressure was usually evident within 30 seconds following the start of injection.

Intracystic pressure: Four cats receiving eight injections responded with an increase of intracystic pressure. Two cats which received four injections gave no response.

Death and narcosis: Our findings confirm those of other investigators. In animals dead of histamine shock, post-mortem examination showed the large veins distended, the right heart engorged and the left heart almost empty. In animals under light anesthesia, the injection of histamine caused a loss of existing reflexes, such as the corneal reflex, etc.

DISCUSSION

In our experiments there was no appreciable difference in the response of cats to histamine injection, under amytal, ether, or mixed anesthesia. The blood pressure response followed very closely that described by Dale and Laidlaw as the "three-phase drop." However, not all animals produced this type of curve. Apparently cats are less susceptible to the second injection of histamine than to the first, as judged by the time necessary for the blood pressure to be restored. Heart rates were reduced in one, unchanged in two, and increased in two cats following histamine injections. They returned to normal as the animal recovered from the shock.

Histamine injection in the carnivora did not affect the coagulation time of the blood or the body temperature. Both the coagulation time and the body temperature decreased progressively throughout the duration of the experiment.

A fleeting definite increase of kidney volume was observed, which was immediately replaced by a profound decrease in volume. It suggests that the preliminary action of histamine on the renal vessels of the cat was a dilatation followed by an active constriction.

From the intact intestinal loop records, it was shown that the intestinal smooth muscle of the anesthetized cat responded in a similar manner as the same when excised and tested in warm Tyrode bath.

Since following sixty-seven percent of the histamine injections there was a definite increase in the intracystic pressure, it suggests that this response was due to the action of histamine. This is in opposition to the view of Dale and Laidlaw, who thought histamine had no direct effect on the bladder musculature.

CONCLUSIONS

We feel that the foregoing simultaneous physiological studies of histamine injection in the cat bear out the following conclusions:

1. That sodium amytal anesthesia may be satisfactorily used in laboratory studies.
2. The typical reaction of the cat to a single rapid injection of histamine is a three-phase drop in blood pressure. There is an abrupt drop, interrupted by partial or complete recovery, followed by a slow, gradual fall to the minimum pressure.
3. The intravenous injection of histamine usually produces either a definite acceleration or no change in the heart rate. In one third or one fourth of the cats it produced a moderate decrease in the heart rate. The rate returns to normal as the blood pressure is restored.
4. That the injection of histamine does not exhibit any noticeable effect on the coagulation of the blood.
5. That it produces no evident change of the rectal temperature in the cat.
6. That histamine injection produces a fleeting dilatation of the renal blood vessels which is immediately followed by what appears to be an active constriction with subsequent decrease of kidney volume.
7. That histamine injection produces an active increase of intestinal pressure.
8. That in two thirds of the cases histamine induces a definite increase of intracystic pressure.
9. That cats dying in histamine shock display an arterial blood pressure near zero. That the large veins are distended, the right heart engorged and the left heart almost empty.
10. A definite effect of narcosis is observed following histamine injection in a cat.

SECTION II.—PEPTONE

Schmidt-Mulheim (*11*) in 1880 discovered that when peptone was introduced intravenously into the systemic circulation of a dog, it produced the remarkable results of delaying the coagulation time of the blood drawn soon after the injection, and at the same time caused a very profound fall of blood pressure. Polletzer (*12*) and Thompson (*13*) have contributed to our knowledge of peptone shock in the dog.

Likewise several authors (*1, 14, 15, 16, 17*) have worked out valuable information concerning peptone shock in the guinea pig and rabbit.

Underhill compared the response of the cat to that of the dog as follows: "In the cat the characteristic symptoms are evoked somewhat less readily, larger doses being necessary to produce comparable results."

Olivecrona (*14*) found that dilution of from 1-250 to 1-750,000 of peptone readily increased the tone of excise intestinal strips of the cat. Dilutions of peptone less than 1-200 produced a marked relaxation and complete loss of rhythmatic contractions. Emery and Griffith (*6*) found the effects of peptone in the cat to be a decrease in liver volume and a fall of blood pressure.

EXPERIMENTAL

This series was composed of twelve normal cats, ranging in weight from 1,650 to 4,600 grams with an average weight of 3,090 grams. Seven were males and five were females.

The twelve cats received twenty-two injections of peptone. Witte's peptone was used throughout and the solution was made fresh for each day's experiments. A boiled ten-percent solution of peptone in physiological saline was cooled and centrifuged to remove the precipitate. The clear supernatent fluid was then used for injection.

Dosage: The dosage for the first ten animals was 0.25 grams of peptone per kilogram body weight. Four tenths grams per kilogram was the dosage for the last two cats of the series.

Injection: All injections were made intravenously by means of a cannula tied into the right femoral vein. Each injection was washed in with sufficient warm Ringer's to make the total volume injected equal ten cubic centimeters.

Anesthesia: Six of the cats were anesthetized by an intravenous injection of 55 mgm. sodium amytal per kilogram. The remaining six were anesthetized with ether.

Methods for determining the mean arterial pressure, heart rates, coagulation time of the blood, rectal temperature, kidney volume, intestinal pressure, and intracystic pressure were the same as those described in the section of histamine.

RESULTS

Blood pressure: A "three-phase drop" followed fifty-nine percent of the intravenous peptone injections. The percentage drop and the time required to reach the minimum value were greater following the first injection than after the second. The average drop of blood pressure following the first injection of peptone was 44.9 percent. The average time required for the blood pressure to reach its lowest level after the first injection was two minutes, twenty seconds. In no case was the recovery of blood pressure complete after the first injection.

The average drop which followed the second injection of peptone into a cat was fifteen percent, and the average time consumed in reaching the low point was forty-five seconds.

Heart rate: Following the first injection six cats showed a moderate slowing of the heart. Of these animals four showed a slowing of six to nine beats per minute, while in two the heart rate dropped eighteen and twenty beats, respectively.

The heart rates of two animals were unaffected, and three exhibited an increase of rate varying from two to eight beats per minute.

The second injection of peptone consistently produced no effect on the rate of the heart.

Coagulation time: The blood of three cats following peptone injection showed an increase of coagulation of from one minute, thirty seconds to three minutes. The blood of three cats displayed a decrease of coagulation time following the first injection, but exhibited an increase of one minute after the second injection. The blood of six cats showed a progressive decrease of coagulability following each injection.

Rectal temperature: In every animal there was a slow, progressive decrease of rectal temperature throughout the duration of the experiment.

Kidney volume: An analysis of the kidney volume records showed that for ten cats injected with peptone there was a marked decrease in volume of the kidney after the first injection. Five of the eight cats receiving two injections showed an increase of kidney volume after the second injection. Neither of the two animals

which received a single fatal injection of peptone showed any change in the volume of the kidney.

Intestinal pressure: The initial reaction of the intestinal smooth muscle of twelve cats receiving injections of peptone, was a loss of muscular rhythm accompanied by a slight or marked relaxation of tone in seven, a slight but definite increase of intestinal pressure in two and no change in three.

It has been shown, then, that following 58.3 percent of the initial peptone injections in cats there was a slight or marked decrease in the tone of the intestinal musculature.

Intracystic pressure: Three cats which received six injections reacted with an increase of intracystic pressure following each injection. The remaining nine cats of this series showed no change in the tone of the cystic musculature following any injection.

Autopsy: Post-mortem examination of the cats dying in peptone shock revealed the veins of the portal system and the interior vena cava distended with blood. The right heart was engorged and the left heart was almost empty.

DISCUSSION

Reports of investigators concerning the reactions of the cat to peptone injections are few. No systematic or correlated simultaneous observations have been found describing the responses of the various organs.

The results as recorded show that the animals react in somewhat a variable manner. Initial intravenous injections of peptone into the cat always produce a drop in blood pressure. The majority of animals respond with the "three-phase drop" as described elsewhere; however, a few show only a single-phase drop following peptone injection. There is never a complete recovery of blood pressure following the first injection. In contrast to the reported response of the dog, our findings showed a decrease in the cat's heart rate in one half of the animals and an increase in one fourth following the first peptone injection; apparently there is also little tendency for the normal heart rate to be regained.

It has been shown that the dog is much less susceptible to the action of the second or third injection of peptone than to the first. Our experiments with the cat indicate that it likewise is refractory to second injections of peptone. The average blood-pressure loss following the second injection was about one third that following the first injection. The heart rate is consistently unchanged after the second or third injection.

Some dogs do not exhibit a loss of blood coagulability following intravenous injection of peptone. We have shown that following about thirty percent of the initial peptone injections in the cat the coagulation time of the blood is increased.

In 83.3 percent of the cases the first injection of peptone produces a marked decrease in the kidney volume of the cat; however, following the second injection of peptone the kidney shows an increase in volume. This might suggest that the initial peptone injection had altered the reactivity or permeability of the renal blood vessels.

The response of the intestinal musculature to peptone in 58.3 percent of the animals is a decrease in tone and a loss of rhythmic contractions.

In seventy-five percent of the animals no response of the bladder is recorded following peptone injection. Nevertheless, a small percentage of animals in this series shows a slight increase of both intestinal and intracystic pressure.

It is shown that the rectal temperature is unaffected by peptone injections.

A perusal of the results shows no correlation in the response manifest and the anesthetic employed. It appears that sodium amytal may be used in the study of experimental peptone shock without fear of depressing or masking some part of the reaction.

CONCLUSIONS

From the foregoing correlated physiological studies of peptone shock in the cat we feel warranted in drawing the following conclusions:

1. That following an initial injection of peptone in the cat, there is a characteristic drop of arterial blood pressure from which recovery is not complete in one hour, with an apparent lessening of susceptibility to further injections.

2. That the heart rate is decreased in one half and increased in one fourth of the animals following the initial injections of peptone. It does not regain its normal value in the duration of our experiments.

3. That following the second injection the blood-pressure drop is relatively small and that the heart rate is unchanged.

4. That a decrease in the coagulability of the blood occurred in over thirty percent of the cats injected.

5. That the response of the intestinal smooth musculature of 58.3 percent of the animals to peptone injections is a decrease in tone and loss of rhythmic contractions.

6. That following seventy-five percent of the peptone injections there is no change in intracystic pressure.

7. That in 83.3 percent of the cats studied there is a consistent decrease of kidney volume following the initial peptone injection, and usually an increase of volume following the second injection.

8. That there is no correlation in changes of rectal temperature with peptone injections.

9. That in fatal peptone shock there is engorgement of the visceral veins together with the large trunk veins of the body.

10. That sodium amytal anesthesia can be used in the study of experimental peptone shock.

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Studies in Anaphylaxis XVII: Physiological Studies of the Hypersensitive Cat

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. ABSTRACT: The authors review the literature and call attention to the fact that in the few studies made by others on anaphylaxis on the cat complex proteins capable of producing the Brodie reaction have been used. By employing crystalline egg albumin they were able to avoid the Brodie reaction. While they were unable to produce active sensitization to this antigen in a series of twenty cats they were successful in obtaining passive sensitization in six out of fifteen cats injected with high-titered antiserum obtained from rabbits. Their results indicated that the failure to produce active sensitization was due to the poor antibody response of the cat to antigenic stimulation. In the passively sensitized cat the anaphylactic response was characterized by a profound drop in arterial blood pressure, a marked reduction in the heart rate, a pronounced decrease in kidney volume, a definite increase or no change in the intestinal and intracystic pressure. The coagulation time of the blood was unaffected. The uterine horns from sensitized cats gave typical Dale reactions. The anaphylactic response did not correlate perfectly with either histamine or peptone responses, although there were resemblances to both.

SECTION 1.—ACTIVE ANAPHYLAXIS

BRODIE (*1*) in 1900 described the exaggerated sensitivity of normal cats to intravenous injections of foreign proteins. Apparently this type of reaction was peculiar to the cat, since the threshold of toxic reactions was much higher for the dog, rabbit, or guinea pigs. All investigators (*2, 3, 4, 5*) who have reported studies of the anaphylactic phenomena in cats have used as sensitizers complex protein material such as horse serum, sheep serum, dog serum, or fresh egg white. These substances, even in small amounts, produce a decided drop of arterial blood pressure when injected intravenously in the normal cat.

Nevertheless, Manwaring (*2*) and Edmunds (*4*) have described a slow drop in blood pressure in sensitized cats following the injection of the shock dose, and thought is was characteristic of true anaphylaxis.

The ambiguous reports suggested the question as to the possibility of actively sensitizing cats with a chemically pure antigen such as crystalline egg albumin. By the use of this antigen it was hoped to eliminate the "Brodie Reaction" and to secure simultaneous physiological responses of the various organs.

The question also arose as to the possibility of *passively* sensitizing cats to crystalline egg albumin.

In all experiments the results were obtained under as nearly identical conditions as experimentation would permit. The methods employed were the same as those reported in the preceding paper (*6*).

EXPERIMENTAL

This series was composed of twenty cats, all of which were grown except one that was used for smooth muscle experiments alone. This was a young female weighing 1,200 grams. The adult cats varied in weight from 1,800 to 3,520 grams. There were sixteen females and four males included in the adult series.

Sensitization: The sensitizing antigen was a solution of four-percent crystalline egg albumin (*7*) in distilled water. The sensitizing dose was 0.5 c.c. of four percent albumin solution per Kg. of body weight. Several methods of injection were utilized in attempting to sensitize the animals of this series. The methods used were:

1. One subcutaneous injection followed at three-day intervals by two intravenous injections.
2. Three intravenous injections given two days apart.
3. Eight to thirteen subcutaneous injections given in three periods of three to five injections on consecutive days with three days rest between periods.
4. Three subcutaneous injections on consecutive days, followed by an intravenous injection the fourth day, allow three days to elapse and repeat.
5. Five to seven subcutaneous injections given at two-day intervals and followed by two intraperitoneal injections of the same spacing.

Incubation period: Periods varying from 8 to 74 days were in-

NOTE.—Studies in Anaphylaxis XVI and XVII belong to a series of investigations of anaphylaxis being directed or conducted by N. P. Sherwood and O. O. Stoland of the University of Kansas.

vestigated. Most of the animals were tested 18 to 26 days after the last injection.

Anesthesia: For each animal ether was administered from a cone until complete surgical anesthesia was established, after which the trachea was cannulated and an ether bottle attached.

Shock dose: The shock dose was 2 c.c. of four percent crystalline egg albumin solution per kg. of body weight. It was injected by means of a cannula tied in the right femoral vein. Sufficient warm Ringer's solution was injected to make sure that all the albumin had entered the circulation.

Precipitin titration: Samples of blood were drawn immediately before and five minutes after the injection of the shock dose. Their precipitin content was determined by use of the ring test and over night settling methods.

RESULTS

The blood pressure showed invariably an injection rise of from four to twenty millimeters of mercury, which was maintained for from 30 seconds to ten minutes. This was essentially the same reaction as of a normal cat when injected with an identical dose.

The heart rate usually exhibited slight slowing. The maximum decrease of rate was ten beats per minute. The coagulation time of the blood and the rectal temperature progressively decreased throughout the duration of the experiments.

The intestinal and intracystic pressures were consistently without change.

The kidney volume usually showed no change; however. a very slight increase sometimes accompanied a pronounced injection rise of blood pressure. A decrease in volume never followed the injection of the shock dose.

The intestinal strips from each of seven cats, and uterine horns from six were removed and suspended in Ringer's solution kept at 37°C. under light tension until the physiological experiments were begun. At that time they were tested by the method of Schultz and Dale for specific contraction with the homologous antigen, crystalline egg albumin. All the intestinal strips as well as the uterine horns failed to respond when tested by this method.

Guinea pigs were injected with the sera of six supposedly sensitized cats in an effort to passively sensitize the pigs to crystalline egg albumin. The cat sera were injected intraperitoneally in five cubic centimeter amounts into 400-gram normal-health guinea pigs.

After twenty-four to seventy-two hours incubation, the guinea pigs were injected intracardially with one cubic centimeter of four percent crystalline egg albumin and were observed for clinical symptoms of anaphylaxis. None of the guinea pigs responded with anaphylactic symptoms.

The sera of twenty-one cats were tested for the presence of precipitins for crystalline egg albumin and all found negative.

Discussion

It is quite evident from the preceding results that no cat in this series displayed any of the recognized symptoms of anaphylactic shock. The possibility that this lack of sensitization was due to nonantigenicity of the crystalline egg albumin had to be ruled out. This was accomplished by at least three biological methods:

(*a*) Guinea pigs could be sensitized by a single subcutaneous injection of one cubic centimeter of four percent crystalline egg albumin. An identical dose when injected intracardially twelve days later produced fatal clinical anaphylaxis.

(*b*) Typical specific contractions of the excised uterine horns from sensitized virgin guinea pigs were demonstrable by Dale's technique.

(*c*) Multiple intravenous injections of crystalline egg albumin in rabbits stimulated the production of easily demonstrable precipitins for that antigen. This method will be described in detail in the following section.

These findings seemed to prove the antigenicity of the crystalline egg albumin. If this were true, the question arose as to why the cats were not sensitized by its injection. It has previously been pointed out that apparently the cat produces no precipitating or passively sensitizing antibodies to crystalline egg albumin. Is there likewise no hemolysins nor bacterial agglutinins produced in response to introduction of their respective antigens? With the hope of ascertaining the answer to this question, a series of three cats was given five intraperitoneal injections of ten percent sheep cells at three-day intervals, and another series of three cats was given intraperitoneal injections of a formalized suspension of *E. typhi* (Rawlin's strain).

It was found for the first series that all the cat sera preceding injection contained hemolysins for sheep cells when undiluted, but not in a dilution of one to ten. After the round of injections there was complete hemolysis of the sheep cells in a dilution of one to ten, but only a trace in a dilution of one to fifty.

None of the animals of the second series showed any agglutinins for *E. typhi* before immunization. After five injections the suspension of *E. typhi* was agglutinated by 1-200, 1-100, and 1-32 dilutions of the respective sera.

Thus it is shown that at best the cat produced antibodies in very small quantities. It was thought that this might be explained by an inadequate absorptive mechanism, or by a complete inability to absorb foreign substances from the peritoneal cavity. However, when trypan blue was injected intraperitoneally, it appeared in the mucous membranes and skin as early as five hours after injection.

Three cats were then injected intraperitoneally with five cubic centimeters of ten percent suspension of chicken cells. One of the cats was killed after the elapse of six, twelve, and twenty-four hours, the spleen and liver removed, embedded, sectioned, and stained. Definite phagocytosis of the chicken cells was observed by the fixed tissue cells of the spleen and liver from the cats killed at 12 and 24 hours. It appears, then, that the cat has an adequate absorption as well as phagocytic mechanism, although it does not respond with active generation of demonstrable antibodies to the introduction of foreign proteins.

The apparent inability of the cat to generate antibodies may account for the entirely negative series just reported. It seems very reasonable that if hemolysins, bacterial agglutinins, and precipitins are not generated in demonstrable quantities, that likewise the sensitizing antibody of anaphylaxis is also absent. This assumption is certainly borne out by the preceding physiological studies of anaphylaxis.

SECTION 2.—PASSIVE SENSITIZATION

It has been pointed out that the literature concerning active anaphylaxis of the cat is very meager, thus it is not surprising that the passive phenomenon is apparently omitted. We have offered an explanation as to why the cat does not readily yield itself to active sensitization. However, it was shown that foreign substances are quickly absorbed from the body cavities of this animal. So the question remains as to the possibility of passively transferring the anaphylactic sensitizer to the cat.

EXPERIMENTAL

This series was composed of fifteen adult, healthy cats, ten of which were females and the remaining five were males. The animals ranged in weight from 1,800 to 3,050 grams.

In each experiment the various physiological responses were recorded simultaneously with a few exceptions which will be noted with their respective analysis. For each animal the anesthesia and the methods of recording the various physiological responses were the same as those described in the section on active sensitization.

Sensitization: High-titered anticrystalline egg albumin sera were produced by repeated injections of four percent crystalline egg albumin solution into the marginal ear vein of rabbits. Seven sera were prepared which showed a precipitin titer of from 1-17,500 to 1-27,500 and which were capable of passively sensitizing 400-gram guinea pigs when injected intraperitoneally in two cubic centimeter amounts. An analogous dose, or five cubic centimeters per kg. body weight, was chosen as the sensitizing dose for cats and was injected intraperitoneally.

Incubation period: The incubation period varied from twenty-four to seventy-two hours.

Shock dose: The shock dose, consisting of two cubic centimeters of four-percent crystalline egg albumin solution per kg. of body weight, was injected through a cannula into the right femoral vein. The cannula was then washed clean of antigen with sufficient warm Ringer's solution to bring the total volume injected to ten cubic centimeters.

RESULTS

Blood pressure: Six cats showed a profound drop of arterial blood pressure following injection of the shock dose. Three of the cats responded with a "three-phase" drop as previously described, and three with a single-phase drop. The drop of blood pressure was initiated from thirty seconds to one minute and forty seconds after the injection of the shock dose was started. The average drop of blood pressure was 42.7 percent. The low point of the curve was reached on an average of two minutes, thirty seconds after injection of the shock dose. The recovery time in the six cats was 4. 7, 8, 8, 20, and 28 minutes, respectively. There was no correlation observed between the percentage drop in blood pressure and recovery time, both the seven-minute and twenty-eight-minute recovery times being associated with fifty-percent drop in blood pressure, while the four-minute and twenty-minute recovery times were associated with thirty-four-percent drops in blood pressure.

The second injection,* consisting of two cubic centimeters of four

* This is the term used to denote the injection of the specific protein to test for desensitization of the animal.

percent crystalline egg albumin per kg. body weight, invariably produced only a transient injection rise of blood pressure. The absence cf a blood-pressure drop following the second injection would suggest complete desensitization of the animal by the shock dose of specific antigen.

Heart rate: Of the six positive animals, all but one exhibited a decrease in heart rate during the period of lowered blood pressure. In three of the animals the reduction of rate was marked, amounting to 26, 81 and 91 beats, respectively; two showed a reduction of 5 and 6 beats, respectively, while in one animal there was no change of rate.

Coagulation time and rectal temperature: In no instance was there a prolongation of clotting time associated with the specific drop in blood pressure. The value of both the coagulation time of the blood and the rectal temperature progressively decreased throughout the duration of the experiments.

Kidney volume: In every case there was a pronounced decrease in the renal volume as the blood pressure fell. Usually the volume of the kidney remained greatly diminished long after the blood pressure had started recovery. In no case was there a decrease in kidney volume following the second injection of albumin.

Intestinal pressure: Of the six cats responding with a drop of arterial blood pressure, four exhibited a definite increase of intestinal pressure following introduction of the shock dose. There was no change of pressure following any of the second injections.

Intracystic pressure: Two animals showed a definite increase of intracystic pressure after injection of the shock dose. There was never any increase of intracystic pressure following the second injection.

Precipitin content and passively sensitizing power for guinea pigs: The sera of fifteen cats were titrated for precipitin content. Samples drawn immediately before injecting the shock dose and five minutes after injection were tested. Both the Ring Test and overnight settling methods were employed. All the sera were consistently negative, even when tested with undiluted antigen.

The passively sensitizing power of the cat sera for guinea pigs was tested as has been described. The sera of three positive reacting cats and one negative reacting cat were employed. A twenty-four hour incubation period was allowed to elapse before injecting the shock dose, which consisted of one cubic centimeter of four-percent albumin solution. None of the guinea pigs displayed anaphylactic symptoms following intracardial injection of the shock dose.

Excised intestinal strips and uterine horns: Two intestinal strips from each of seven negative cats and from two positive cats were tested for specific contraction by the Schultz-Dale technique. None of the strips from the negative animals responded with a specific contraction, while the strips from both positive cats reacted with a marked contraction when one cubic centimeter of two-percent egg albumin was added to the twenty cubic centimeters Tyrode's solution bath.

After renewing the bath with fresh Tyrode's, a second addition of an identical dose of albumin caused no contraction. A subsequent addition of barium chloride produced the characteristic shortening.

The uterine horns from three negative cats and from two positive cats were tested by the same method. The horns from one positive cat were hyperirritable, relaxation was unobtainable and a satisfactory test was impossible. The horns from the other positive cat responded with a maximum contraction when 0.3 c. c. of two-percent albumin was added to the 20 c.c. bath. After renewal of the bath, the addition of an identical amount of albumin induced no change in the tone of the horns; however, upon the addition of barium chloride a marked contraction resulted. None of the horns from the negative cats showed any contraction except when barium chloride was added to the bath.

DISCUSSION

By correlation of the physiological responses of the passively sensitized cat to an intravenous injection of the homologous antigen, it is possible to describe anaphylactic shock in the anesthetized animal. Soon after the intravenous injection of the shock dose, the arterial blood pressure abruptly falls, and at the same time the heart rate is markedly reduced. The oncometric kidney volume is also greatly diminished. The intestinal pressure definitely increases and at times this is also true of the intracystic pressure. Marked specific contractions are exhibited by excised intestinal strips and uterine horns when brought in contact with small amounts of the homologous protein. The coagulation time of the blood and the rectal temperature are apparently unaffected. This would seem to indicate that a heparin-like substance is not liberated during anaphylactic shock in the cat. There are no demonstrable circulating antibodies for crystalline egg albumin present. This fact would indicate that the antibodies injected are either quickly fixed by the animal's tissues or hastily excreted. Since anaphylactic shock could be demonstrated, the former suggestion seems more fitting. There is 100 percent cor-

relation of the excised smooth muscle responses with those of the arterial blood pressure, kidney volume, etc.

It has been pointed out that all the rabbit antisera used for passive sensitization in these studies were capable of passively sensitizing guinea pigs to a subsequent injection of crystalline egg albumin, yet only forty percent of the cats in this series were rendered hypersensitive to the same antigen.

The guinea pig has long been considered the animal "par excellent" for demonstrating the anaphylactic phenomena. It has been shown by Spain and Grove (*8*), Sherwood and Stoland (*9*), Tim and Kuratchkin (*10*) and others that the titer of the anaphylactic sensitizer did not parallel the titer of the precipitating antibody in antisera. Our results in passively sensitizing cats with rabbit antisera bear out these findings. It is likewise demonstrated that the cat does not yield to passive sensitization as readily as does the guinea pig. Sherwood and Stoland (*10*) have shown that some dogs are not passively sensitized, while others are by injections of the same antiserum. This recalls to mind the additional factor of individual variation.

Although the physiological responses of the cat to histamine and peptone injections resemble those of anaphylactic shock in the cat, there are sufficient differences to render it questionable that either histamine or peptone is solely responsible for the anaphylactic phenomenon. One of us, Sherwood (*11*), has recently summarized and discussed the evidence for and against histamine as the essential factor in anaphylactic shock.

CONCLUSIONS

From the results of the foregoing physiological studies the following conclusions were drawn:

1. That in the light of our results, it appears that the so-called anaphylactic phenomena in cats as reported by earlier investigators were exaggerated "Brodie Reactions."
2. That active sensitization does not occur in cats, or is so rare that it was not observed in the series of this study.
3. That the refractory character of cats is due to an inability to generate sufficient antibodies, since only slight antibody formation was demonstrated following the injection of vastly different antigens such as sheep cells, crystalline egg albumin and suspensions of bacteria.
4. That cats can be passively sensitized by injecting intraperitoneally adequate amounts of high-titered rabbit antisera.

5. That the anaphylactic responses of such passively sensitized cats are specific, and that the cats show complete desensitization upon reinjection of the specific antigen.
6. That the Dale reaction can be used as a criterion of feline sensitization.
7. That the symptoms of experimental anaphylaxis in the anesthetized cat are:
    i. Profound drop in blood pressure.
    ii. Marked decrease in heart rate.
    iii. Decided decrease in kidney volume.
    iv. Increase of intestinal pressure in the majority of animals.
    v. Specific contractions of excised smooth muscle such as intestinal strips and uterine horns.
    vi. Desensitization upon reinjection.

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THE UNIVERSITY OF KANSAS
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A New Fish, *Listracanthus eliasi*, from the Pennsylvanian of Nodaway County, Missouri

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ABSTRACT: *Listracanthus eliasi* Hibbard n. sp., based on complete spine and two associated spines, smallest known species of the genus *Listracanthus*.

AMONG some ichthyodorulites in the Museum of Vertebrate Paleontology, collected by Prof. M. K. Elias of the Kansas Geological Survey, are three spines representing an undescribed form of *Listracanthus*.

Listracanthus eliasi n. sp.

(Pl. XIX)

Types: Holotype No. 884F, University of Kansas Museum of Vertebrate Paleontology. Complete spine with truncated base. Paratypes, K.U.M.V.P. 885F-6F; dorsal part of spines lacking base.

Horizon and Type Locality: Taken from a concretion a few feet above Elmo coal, in the Cedarvale shale, Wabaunsee group, Virgil series of the Middle Pennsylvanian of Mid-Continent. Taken by M. K. Elias, 1934, at Carpenter's coal mine, 2 miles west and 3 miles south of Burlington Junction, Nodaway county, Missouri.

Diagnosis: The spine is delicate, flattened and very thin. The sides contain from nine to ten longitudinal carinae at the base of the spine. Only five longitudinal carinae continue throughout the length of the spine, these being the five nearest the convex edge. The outermost carinae on the concave side of the spine at its base are lost as the spine gradually tapers off from the base to its apex. The concave side of the spine is set with slender, sharply pointed, closely packed teeth which are directed upward. The teeth are

missing from the convex side with the exception of the extreme tip of the spine where a few scattered teeth may occur. The spine narrows abruptly above the truncated base on the concave side, giving a gentle arched appearance. The holotype is 15 mm. in length; width of truncated base, 3 mm.; greatest width of spine above base, 2 mm.; the teeth first appear on the concave side of the spine 4 mm. from the base, on the convex side, 13 mm. Nine longitudinal carinae are present with only five extending to the tip of the spine. The paratypes agree with the holotype except that the bases of the spines are missing. No. 886F is 15 mm. long, having ten longitudinal carinae, only five continuing to tip of the spine. No. 885F with base missing is 15.5 mm. in length and possessing ten longitudinal carinae.

Listracanthus eliasi may be distinguished from the other forms by its small size and the fact that the teeth are nearly missing on the convex surface and confined only to the tip of the spine. Though *Listracanthus* has been found in many localities in Europe it is one of the rarer forms found in the Pennsylvanian of North America, being known only from the coal measure of Ohio and Illinois; also from a single locality in Andrew county, Missouri, in the Cherokee shale just overlying the Springfield coal.

PLATE XIX

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Distribution of the Genus *Reithrodontomys* in Kansas

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ABSTRACT: The occurrence of *Reithrodontomys albescens albescens* (new state record); *R. a. griseus; R. megalotis dychei* and *R. fulvescens aurantius* in Kansas with notes on distribution and habits.

THE purpose of this paper is to give the distribution of the harvest mice of Kansas as represented by the specimens in the Kansas University Museum of Mammals. In no way does it present a clear picture of the distribution within the state due to the many areas not yet studied. Field notes are included which may be of value to others collecting in the field.

In the past six years of collecting in Kansas the following observations have been made on the habitat of *Peromyscus* and *Reithrodontomys.* The genus *Peromyscus* occurs abundantly through the state in all counties. In all of the counties carefully worked both the *Maniculatus* and *Leucopus* groups have been found. Though both occur in the same region, they inhabit entirely different ecological stations. *Peromyscus leucopus* is confined chiefly to the more humid areas of a given region; that is, along streams and lowlands. *Peromyscus maniculatus* is found in the drier parts of a region of upland meadows, fields and pastures. There is a slight overlapping of range in the eastern one third of Kansas, that area east of the Flint Hills known as the Osage Plains. After passing west of the Flint Hills it is found that *Peromyscus leucopus* never encroaches upon the areas inhabited by *P. maniculatus,* but is restricted entirely to the most humid stations, especially along the more permanent streams. It is in this region that we find the *Maniculatus* group to some extent encroaching upon the stations favored by *leucopus.* A

slight increase in elevation of a few feet giving a strictly grassland area is found to be a perfect barrier to *leucopus* upon entering the range of *maniculatus*. It is probable that the few *maniculatus* taken along the streams with *leucopus* in the extreme western part of the state come to these stations for water.

The *Albescens* group, trapped in Greenwood, Douglas, Pottawatomie, Barber and Hamilton counties, has been taken only in the areas inhabited by *Peromyscus maniculatus*. The specimens of *Reithrodontomys m. dychei* taken in Douglas county have been found only to inhabit the humid stations occupied by *Peromyscus leucopus noveboracensis*. The nineteen specimens of *R. m. dychei* taken in Rawlins county along Beaver creek in the summer of 1936 were found associated with *Peromyscus leucopus aridulus*. Though only a very few specimens of *P. m. nebrascensis* were taken in the timber along the streams in association with *P. l. aridulus* and *R. m. dychei*, the latter was never taken away from the stream in the surrounding uplands inhabited by *P. m. nebrascensis*. Insufficient field work has been done in Kansas to state definitely that the *Albescens* group inhabited only the stations occupied by *Peromyscus maniculatus*, and that the *Megalotis* group will inhabit only the stations occupied by *Peromyscus leucopus*. Though all evidence, however, seems to point to this condition and it should be expected, especially in the regions where both species of *Reithrodontomys* occur.

Reithrodontomys albescens albescens Cary

1903. *Reithrodontomys albescens* Cary, Proc. Biol. Soc. Washington, Vol. 16, p. 53.

Type Locality. Eighteen miles northwest of Kennedy, Cherry county, Nebraska.

Range in Kansas. Hamilton, Kearny and Morton counties.

Characters. More pallid with a greater yellowish wash than *griseus*.

Measurements. In millimeters, of two adult males from two miles east of Coolidge, Kan., Hamilton county; length, 120-121; tail, 45-54; hindfoot, 15-15; ear, 12-12; greatest length of skull, 19.3-broken; zygomatic breadth, 10.1-10.3, respectively.

Remarks. Heretofore the range of *Reithrodontomys a. albescens* Cary has been confined to the sand-hill region of Nebraska and western South Dakota; west to Loveland, Colo.

Nine specimens from Hamilton and Morton counties were found to represent an undetermined race in Kansas. The specimens were sent to A. H. Howell for identification and are referred to *R. a.*

albescens. It is not known under what conditions the specimens were taken in Morton and Kearny counties, but the specimens from Hamilton county were taken about two miles east of Coolidge, Kan., on the north side of the Arkansas river. The harvest mice were found on the secondary flood plain which supports what is called "Alkali or Salt Grass," in that area. The sand hills are south of the river two or three miles. The specimens were trapped by using rolled oats for bait. They were found under a different environment than those from Nebraska, South Dakota and Colorado, and were taken in association with *Peromyscus maniculatus*. There is a male specimen in the collection taken eight miles east of Keys, Cimarron county, Oklahoma, July 8, 1932, by Eleanor Henderson referable to this form.

The specimens are lighter than typical *R. a. albescens* and will probably be found to represent a new race when sufficient material is at hand; since they do not compare with *R. montanus*.

Reithrodontomys albescens griseus (Bailey)

1905. *Reithrodontomys griseus Bailey*, North American Fauna, No. 25, p. 106.
1914. *Reithrodontomys albescens griseus* Howell, North American Fauna, No. 36, p. 23.

Type Locality. San Antonio, Bexar county, Texas.

Range in Kansas. See map.

Characters. Similar to albescens, but darker; total length less than 130 mm. and tail less than 60 mm.

Measurements. Average and extreme measurements in millimeters of 9 adult females from Kansas: length, 121 (108-126); tail, 53 (50-55); hind foot, 15.6 (15-16); ear, 12 (12-12); greatest length of skull, 20.1 (19.1-21.4); zygomatic width, 10.6 (9.9-11.1).

Measurements of 10 adult males from Kansas: length, 118.5 (108-122); tail, 54 (44-56); hind foot, 16 (14-18); ear, 12 (11-13); greatest length of skull, 20.4 (19.1-21.7); zygomatic width, 10.6 (10-11).

Remarks. *Reithrodontomys albescens griseus* occupies the largest range in Kansas of any of the harvest mice. It has not been found abundant in any area, though it can be considered common. In the collect'on there are thirty-seven specimens. Those that have been trapped were taken by using rolled oats for bait. The large number of *Peromyscus maniculatus* occurring in the same area probably accounts for the fact that so few are taken by sets. In no region have we collected out the more abundant forms giving the less abundant forms a chance to visit the sets. It is of interest that a number of specimens have been taken at night while collecting

with a lantern in grassy areas. A number of specimens have been taken along high, stony ridges in pastures while turning stones for reptiles and amphibians.

Two immature specimens 83 mm. and 84 mm., respectively, were taken July 10, 1911, in Clark county; a female was taken in Doniphan county, November 26, 1924, that contained 5 embryos. During April, 1932, a female (No. 8660 K. U. M. M.) was taken in Douglas county while collecting at night and placed in a cage in the laboratory. She became very tame and allowed herself to be handled. A nest was built out of cut bluegrass in which 5 young were born, April 25. Four of the young lived in the laboratory until they were made into study skins.

Reithrodontomys megalotis dychei (Allen)

1895. *Reithrodontomys dychei* Allen, Bull. American Mus. Nat. Hist., Vol. 7, p. 120.
1895. *Reithrodontomys dychei nebrascensis* Allen, Bull. Amer. Mus. Nat. Hist., Vol. 7, p. 122.
1914. *Reithrodontomys megalotis dychei* Howell, North Amer. Fauna, No. 36, p. 30.

Type Locality. Lawrence, Douglas county, Kansas.

Range in Kansas. See map.

Characters. Distinguished from *Albescens* group by larger size, more intense ochraceous coloration, lack of dark dorsal area, an oval-shaped foramen magnum which is more rounded in *Albescens* group. Length 130 mm. to 150 mm.; tail, 62 to 76 mm.

Measurements. Average and extreme measurements in millimeters of 9 adult females from Kansas: length, 139 (130-149); tail, 66 (62-71); hind foot, 17 (16-18); ear, 12.75 (12-13); greatest length of skull, 20.8 (20-21.8); zygomatic width, 10.8 (10.3-12). Average of 6 adult males from Kansas: length, 140 (132-145); tail, 67 (63-76); hind foot, 17 (16.5-17.5); ear, 13 (13-14); greatest length of skull, 21.3 (20.5-22.5); zygomatic width, 11.1 (10.5-12).

Reithrodontomys megalotis dychei, so far as known, is confined to the northern one half of the state. It is found along the streams and lowland fields. In Douglas county, where a more intensive study of the mammals has been carried on than in any other county of the state, fifty-three specimens have been taken, while only twenty-one specimens of *R. a. griseus* were taken over the same period. The ratio of *Peromyscus leucopus* to that of *P. maniculatus* taken in Douglas county is considerably greater, 4:1 ratio. The specimens of *Reithrodontomys m. dychei* taken in Rawlins county, in the ecological stations found inhabited by *Peromyscus l. ardilus*, live at a considerably higher and drier altitude than can be found on the extreme uplands of Douglas county, though the stations inhabited

in Rawlins county are the most humid in that county. So far in Douglas county only a slight overlapping has been found in the range of the two species of harvest mice, though no greater than that of the species of *Peromyscus*.

A female, No. 3806, was taken March 28, 1920, in Douglas county, which contains 4 embryos; female No. 6157, taken April 26, 1928, in Douglas county, contained 5 embryos 2 mm. in length. Two immature specimens were taken July 28, 1896, in Leavenworth county, in a timothy meadow, which measured respectively 82.5 mm. and 86.2 mm.

Reithrodontomys fulvescens aurantius (Allen)

1895. *Reithrodontomys mexicanus aurantius* Allen, Bull. Amer. Mus. Nat. Hist., Vol. 7, p. 137.
1899. *Reithrodontomys chrysotis* Elliot, Field Columb. Mus. Publ. 37, Zoöl. Ser., Vol. 1, p. 281.
1914. *Reithrodontomys fulvescens aurantius* Howell, North Amer. Fauna, No. 36, p. 48.

Type Locality. Lafayette parish, Louisiana.

Range in Kansas. Confined to the Austroriparian zone of Kansas known as the Cherokee lowland (see map).

Remarks. Known only from 2 specimens collected in Cherokee county, respectively December 1913, and December 1915, by Vic Housholder.

Specimen No. 4478, University of Kansas Collection, reported by J. D. Black, Journal of Mammalogy, Vol. 16, No. 3, pp. 231-232, as *Reithrodontomys f. aurantius* from Anderson county, Kansas, is the skin of *R. a. griseus*. The specimen has been identified by Doctor Kellogg of the U. S. National Museum. The measurements are typically those of *R. a. griseus*. The upper part and sides of the specimen are more richly colored and the underpart more heavily washed with yellow than in typical specimens of *R. a. griseus*, but correspond with the color phase taken in Harvey county.

PLATE XX

Map of Kansas showing the distribution of the Harvest Mice

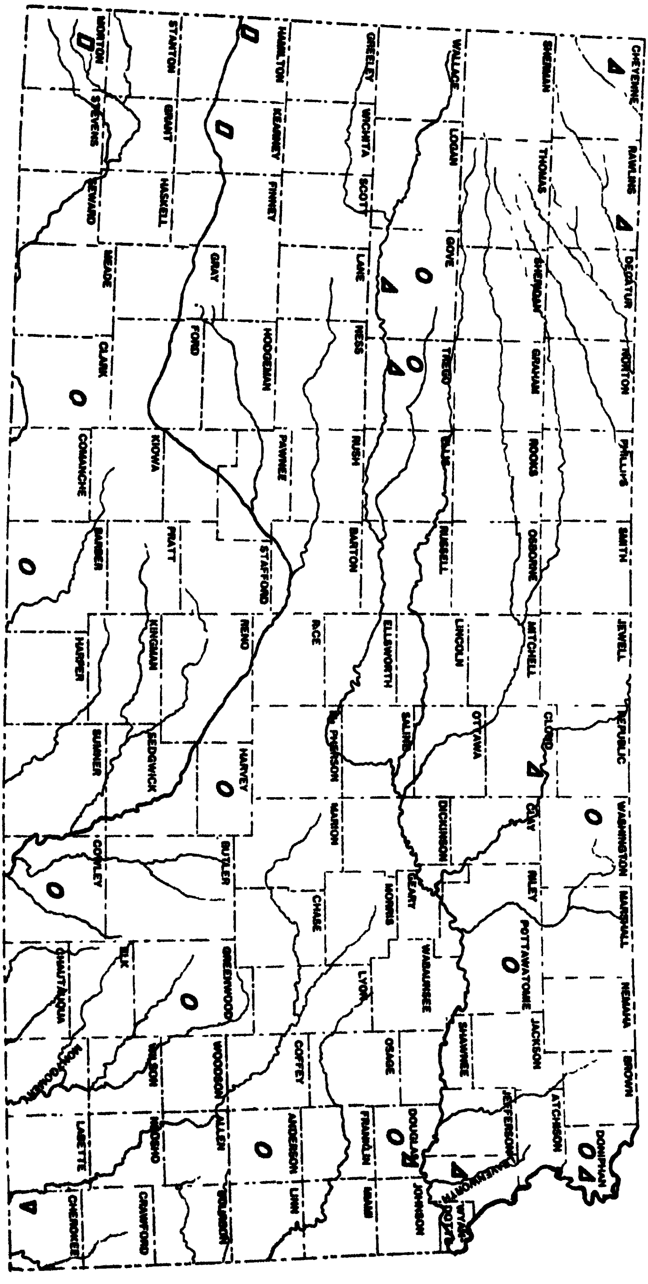
□ *Reithrodontomys albescens albescens* Cary.

○ *Reithrodontomys albescens griseus* (Bailey).

△ *Reithrodontomys megalotis dychei* (Allen).

▽ *Reithrodontomys fulvescens aurantius* (Allen).

PLATE XX


MORTON
STANTON
HAMILTON
GREELEY
WALLACE
SHERMAN
CHEYENNE
STEVENS
GRANT
KEARNEY
WICHITA
LOGAN
THOMAS
RAWLINS
SEWARD
HASKELL
FINNEY
SCOTT
GOVE
SHERIDAN
DECATUR
MEADE
GRAY
LANE
CLARK
FORD
HODGEMAN
NESS
TREGO
GRAHAM
NORTON
COMANCHE
KIOWA
PAWNEE
RUSH
ELLIS
ROOKS
PHILLIPS
BARBER
PRATT
STAFFORD
BARTON
RUSSELL
OSBORNE
SMITH
HARPER
KINGMAN
RENO
RICE
ELLSWORTH
LINCOLN
MITCHELL
JEWELL
SUMNER
SEDGWICK
HARVEY
SALINE
OTTAWA
CLOUD
REPUBLIC
COWLEY
BUTLER
MARION
DICKINSON
CLAY
WASHINGTON
CHASE
MORRIS
GEARY
RILEY
MARSHALL
CHAUTAUQUA
ELK
GREENWOOD
LYON
WABAUNSEE
POTTAWATOMIE
NEMAHA
MONTGOMERY
WILSON
WOODSON
COFFEY
OSAGE
SHAWNEE
JACKSON
BROWN
LABETTE
NEOSHO
ALLEN
ANDERSON
FRANKLIN
DOUGLAS
JEFFERSON
ATCHISON
DONIPHAN
CHEROKEE
CRAWFORD
BOURBON
LINN
MIAMI
JOHNSON
LEAVENWORTH

THE UNIVERSITY OF KANSAS
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A Lower Jaw of *Martinogale alveodens* Hall

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IN THE spring of 1935 Dr. Edward H. Taylor and the author, on a field trip to western Kansas, were fortunate in securing the right mandible of the little-known mustelid, *Martinogale alveodens* Hall. The specimen was collected in the Lower Pliocene beds of the SW¼ sec. 26, T. 10, R. 38 W., Sherman county, Kansas. It is sufficiently complete to warrant this further description.

I am grateful to Professors E. H. Taylor and H. H. Lane for their help in the preparation of this report; to Mr. C. D. Bunker and Dr. Glover Allen for the use of recent material for comparison; and to Mr. L. I. Price for retouching the photographs.

This specimen (Kansas Univ. Mus. Vert. Pal., No. 3833) consists of a complete right mandible with C, Pm_4, and M_1. The remainder of the teeth are represented only by their alveoli. It is undoubtedly the jaw of a young adult, as the teeth are practically unworn.

The mandible of *Martinogale alveodens* is about two thirds as long as that of *Spilogale interrupta* and is quite similar in general contours. The inferior margin does not exhibit the marked antero-posterior convexity of profile seen in the mandible of *Mustela cicognanii cicognanii* and the jaw is less heavily constructed. A distinct chin is developed anteriorly, a feature faintly discernible in *Spilogale* but lacking in *Mustela*. The symphysis, in contrast to its inferior posterior elongation in living weasels, is restricted posteriorly and is no broader inferiorly than the maximum depth. The three mental foramina present are situated laterally below the canine, below Pm_2, and below Pm_4, respectively. The number and position of the mental foramina are to be considered as variable characters as only two were present in the type specimen; in all specimens of

Spilogale examined the number varies from 2 to 4, and from right side to left side in widely divergent positions. The coronoid process shows a development proportionately similar to that of recent skunks, except that in side view the posterior face has a slightly more concave profile. The articular process is relatively more heavily developed. The masseteric fossa is less strongly pronounced and the angle of the jaw is more prominent than in *Spilogale*. *Mustela* differs from *Martinogale* in the above respects, mainly in the convex profile of the posterior face of the coronoid process in side view, and in the greatly receding angle of the jaw.

The dental formula in the mandible is $I_{1\ 2\ 3}$, C_1, $Pm_{2\ 3\ 4}$, and M_{1-2}. The incisors, judging from the alveoli, are crowded together, so that they lie in a plane nearly parallel to that of the symphysis instead of transversely. The relationships of the incisors are the same as those found in *Spilogale interrutpa* and *Mustela cicognanii cicognanii*. The only difference apparent is the greater degree of mesial crowding and consequent greater reduction of I_1 found in *Martinogale*. The alveolus of I_2 is large and is located between the symphysis and canine. Directly beneath is the much reduced alveolus of I_1. The alveolus of I_3 lies almost directly below but a little lateral to that of I_2 and closely approximates it in size.

The canine is proportionately similar in length and contours to that of *Spilogale interrupta*. Both differ from *Mustela cicognanii cicognanii* in sharper upward curvature and in a decidedly more prominent cingulum on the posterior and medial surfaces. The alveoli of Pm_2 indicate that it was a small double-rooted tooth crowded forward against the base of the canine so that it sat transversely in the jaw. The alveoli of Pm_3 are somewhat larger than those of Pm_2 and lie laterally on the superior surface of the mandible, indicating that the tooth had its anterior end crowded outward, forming nearly a right angle with Pm_2. Pm_4 is large with no accessory cusps, but a well-developed heel and a smaller cusp anteriorly on the lingual side. The main cusp of Pm_4 is produced upward and backward and the tip is higher than the protoconid of M_1. A cingulum extends entirely around the tooth, and is more pronounced medially. Three sharp crests, anterior, medial, and posterior, extend from the tip of the crown to the cingulum.

The length of M_1 is equal to its distance from the canine. The protoconid is higher than the paraconid. The metaconid, located directly medial to the protoconid, is but slightly shorter than the paraconid and hidden by it in side view. The lateral crest of the

heavily basined talonid is carried medially behind the protoconid and is separated from the posterior crest of the latter by a distinct notch. The sharp and distinct medial crest of the talonid is not as high nor as heavily developed as the lateral crest. It is continuous with the posterior crest of the metaconid. An indistinct hypoconid is apparent on the lateral crest. A weakly developed cingulum may be traced around the entire tooth. The alveoli of M_2 show that this tooth was less reduced than in the living forms of the subgenus *Mustela,* and was double rooted.

Comparison with the type material shows the specimens to be similar in most respects. The chief differences are listed below.

(1) On M_1 there is a distinct notch between the lateral crest of the talonid and the posterior crest of the protoconid, whereas the corresponding crest of the talonid in the type was described as being continuous with the posterior crest of the protoconid.

(2) The alveoli of Pm_2 indicate a smaller double-rooted tooth. The single alveolus of Pm_2 in the type is larger than the alveoli of Pm_3.

(3) The indices of Pm_4 and M_1 (width divided by length) are 0.64 and 0.47, respectively, as compared with 0.50 and 0.38 of the corresponding teeth of the type and thus indicate proportionately shorter and broader teeth.

These differences may be explained on the basis of sexual dimorphism in view of the great number of striking similarities between the two specimens and the improbability that two closely related species would be found in a deposit of such limited local extent. This is especially probable since sexual differences in size and to lesser degree in structure are markedly evident in the living representatives of this group.

Summarizing, *Martinogale* differs from *Mustela* not only in the general contours of the mandible: the distinct chin, short deep symphysis, the concave posterior profile of the coronoid process, and the prominent angle of the jaw; but also in dental characters: the crowded Pm_2 in process of reduction, the extremely strong metaconid, the well-developed lateral crest of the heavily basined talonid which exhibits no tendency toward a developing trenchant condition, and in the less reduced and still double-rotted M_2. It is of particular interest to note that all these differences from *Mustela* denote points of similarity between *Martinogale* and *Spilogale,* as comparisons throughout the above descriptions show. On the basis of these osteological and dental characters this Pliocene species should

be classed with *Spilogale* until the discovery of the skull shall indicate its true phylogenetic position.

Measurements of Specimens of *Martinogale alveodens* Hall in the University of Kansas Museum of Vertebrate Paleontology

	No. 3473 (Type) MM.	No. 3833 MM
Total length of jaw		21.9
Length of tooth row from posterior base of C to posterior base of M_1		9.9
Length Pm_3	2.5	2.0*
Breadth Pm_3	1.0	1.3*
Length Pm_4	3.0	2.8
Breadth Pm_4	1.5	1.8
Length Pm_2 to and including Pm_4		5.0*
Length M_1	5.8	5.3
Transverse breadth at metaconid	2.1	2.5
Length of talonid	2.5	2.1
Breadth of talonid	2.0	2.1
Depth of mandible at anterior base of M_1	3.3	3.4
Breadth of mandible below trigonid of M_1	2.2	2.2

* Measurement of Alveoli.

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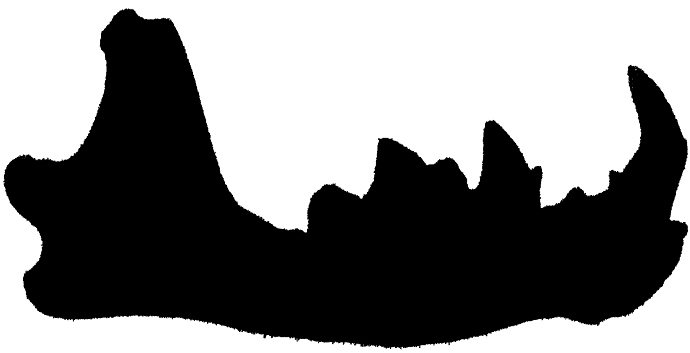
1.

2.



3.

EXPLANATION OF PLATE XXI

FIGS. 1 to 3 Right mandibular ramus and lower teeth of *Martinogale alveodens* Hall (1930), No 3833, Univ Kan Mus Vert Paleontology; from sand deposit near the top of the Lower Pliocene. SW ¼, sec 26, T 10, R 38 W., Sherman county, Kansas

1. Crown view, × 4
2. Medial view, × 4
3. Lateral view, × 4

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Weights and Linear Dimensions of the Skull and of Some of the Long Bones of the Mourning Dove (*Zenaidura macroura carolinensis*)

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A CAREFUL search of the literature shows that the number of statistical studies on bird skeletons is just about as limited as it is for mammalian skeletons. Schneider and Dunn ('24) studied the length and breadth of the skull and the lengths of four long bones in a series of 350 adult male and 46 adult female chickens. The léngth and width of the head and the weights and lengths of the six long bones of the turkey hen have been reported (Latimer and Rosenbaum, '26). Lerner ('37) has reviewed the literature on the growth of the chicken skeleton, but for the adult forms of other birds there is very little except for a few measurements in the literature on taxonomy. This series of dove skeletons is not as large as could be desired, but it is hoped that these data will be of some value in filling a gap in our knowledge of avian osteology.

Following the plan of the two earlier papers on the mammal skeletons, this study will give first the average weights and dimensions of the skull and of six of the long bones, the coefficients of variability and the sex differences in the various measurements. Next the correlations between the skull weight and the weights of the long bones and the correlations between three dimensions of the skull with the other skull dimensions and the lengths of the long bones will be presented. Very frequently linear dimensions of the skull are given in taxonomic papers and this study of the relative lengths should show how valid the use of these measurements is in giving an idea of the size of the other parts of the skeleton. The last topic will be the question of symmetry of the paired bones.

MATERIAL AND METHODS

These skeletons are a part of the University Museum collections and they were all prepared in the same excellent manner. The

method is the same as that used in the preparation of the earlier reports on the other two series of skeletons. A very few of the parts were injured so that weights or measurements could not be made, but as many measurements as possible were made on each skeleton. One of the skeletons was evidently that of a young bird with incomplete ossification, and this entire skeleton was not used in this study. There were 26 male and 14 female skeletons used. The small numbers of each sex, especially the females, will not warrant final conclusions as to sex differences.

The weights were made first, or before the bones were handled much. The bones were not oven dried, but the bones of an entire skeleton were kept together in a small pasteboard box and the boxes were stored in a dry room for some time before weighing. Each of the paired bones was weighed and measured separately and the weights and lengths in all but table four are the sum of the weights or the average length of the two bones. In making the weights as well as in measuring the lengths, the first one of a pair of bones picked up was weighed or measured, so that there might not be constant sequence and possible personal equation in these measurements. All weights were made on a chemical balance sensitive to $^{1}/_{10}$ milligram. The bones were not weighed in closed containers and the weights were recorded to the nearest milligram.

A vernier caliper reading to $^{1}/_{10}$ millimeter was used in making all of the linear measurements, except the total length and wingspread. These two measurements were recorded on the data card with each skeleton and were made at the time the skeleton was prepared by the museum workers. The wingspread was given for but ten skeletons, equally divided as to sex. The methods of making ten of the skull measurements are indicated in figure 1. The skull height is the maximum height with the fixed arm of the caliper held parallel to the base of the skull. The length of the mandible is the maximum length from the symphysis to the posterior end of the left side. The lengths of the long bones are all the maximum length with the long axis of the bone held parallel to the back of the caliper. The sternal length is the maximum length in a line connecting the anterior end of the keel and the posterior end held parallel to the back of the caliper. The sternal height is the maximum depth of the keel measured from the inside of the sternum just posterior to the anterior end and with the anterior border of the keel held parallel to the back of the caliper.

The formulae used in computing the values given in the tables are those given by Dunn ('29). All of the computations were carried to

more decimal places than given in the tables and all computations were carefully checked. The junior author made all of the linear measurements and the weighing and the preparation of the paper were done by the senior author.

We wish to express our gratitude to Mr. C. D. Bunker for permitting us to study these beautifully prepared skeletons and to Miss Edna Mae McConnell for her careful work in aiding with the statistical work.

MEASUREMENTS, VARIATION AND SEX DIFFERENCES

The average ponderal and linear measurements and their probable errors are given in the second column of table 1. The last column gives the significant ratios or the difference between the measurements of male and female divided by the probable error of the difference. The least variable of the coefficients of variation of the

TABLE 1

Average measurements, coefficients of variation and significant ratios

	Average weight in grams.	Coefficient of variation.	Difference / P. E. diff.
Skull and mandible	0.345 ± 0.0035	9.42 ± 0.73	2.10
Humerus	0.527 ± 0.0033	5.91 ± 0.45	3.73
Radius	0.165 ± 0.0018	9.96 ± 0.76	1.70
Ulna	0.399 ± 0.0054	12.29 ± 0.97	0.80
Femur	0.240 ± 0.0045	17.38 ± 1.37	3.48
Tibiofibula	0.323 ± 0.0037	10.50 ± 0.82	0.84
Tarsometatarsus	0.138 ± 0.0015	10.24 ± 0.79	4.71
	Average length in millimeters.		
Skull length	41.64 ± 0.191	4.29 ± 0.32	1.22
Basion-occiput	7.06 ± 0.058	7.57 ± 0.58	0.15
Basion-spine sphenoid	8.13 ± 0.038	4.28 ± 0.33	4.33
Spine sphenoid-tip beak	27.14 ± 0.108	3.69 ± 0.28	0.61
Occiput-hinge	26.13 ± 0.087	3.12 ± 0.24	3.10
Hinge-tip beak	17.67 ± 0.100	5.32 ± 0.40	1.11
Mandible	29.74 ± 0.129	3.92 ± 0.31	0.89
Skull height	15.80 ± 0.063	3.63 ± 0.28	1.00
Bitemporal width	15.95 ± 0.039	2.30 ± 0.17	3.02
Interorbital width	9.02 ± 0.093	9.69 ± 0.74	1.13
Foramen magnum length	3.53 ± 0.031	7.80 ± 0.62	1.61
Foramen magnum width	4.36 ± 0.024	5.19 ± 0.39	0.09
Sternal length	52.52 ± 0.213	3.66 ± 0.29	5.34
Sternal height	20.42 ± 0.092	4.19 ± 0.32	4.07
Interacetabular width	18.73 ± 0.103	5.07 ± 0.39	0.52
Humerus	31.98 ± 0.079	2.30 ± 0.17	3.24
Radius	33.40 ± 0.109	3.06 ± 0.23	2.88
Ulna	36.87 ± 0.102	2.52 ± 0.19	2.81
Femur	28.35 ± 0.083	2.70 ± 0.21	3.97
Tibiofibula	38.01 ± 0.111	2.68 ± 0.21	3.68
Tarsometatarsus	20.91 ± 0.075	3.34 ± 0.26	4.56
Total length	280.73 ± 2.091	6.71 ± 0.53	2.99
Wingspread*	148.45 ± 2.17	6.84 ± 1.04	....

* Ten cases.

weights is the humerus, with the skull weight second. The weight of the femur is the most variable, or 2.94 times as variable as the weight of the humerus. The linear dimensions are less variable, as is to be expected, and the humerus and the bitemporal width of the skull have the lowest coefficients of variation. The three bones of the hind limb are 36 percent more variable in weight and 11 percent more variable in length than the three bones of the fore limb. The interacetabular diameter and the two dimensions of the sternum are more variable than the lengths of the six long bones and the total length and the wingspread are still more variable. The average of the coefficients of variation of the six long bones is 2.77 percent and the similar average for the twelve dimensions of the skull is 5.07 percent.

The bitemporal width or skull width is the most constant of all of the skull dimensions, and it happens to be the same as the lowest coefficient of variation of the lengths of the long bones, or 2.30 percent. The interorbital diameter is the most variable of all of the skull dimensions, thus these two transverse measurements form the two extremes of all of the skull dimensions. The interorbital diameter is limited by a thin edge of bone on each side as shown in figure 1. The central part of the bone provides adequate strength and so the edges may vary considerably without any significant re-

TABLE 2

Average measurements and coefficients of variation for males and females

	Males.		Females.	
	Average weight in grams.	Coefficient of variation.	Average weight in grams.	Coefficient of variation.
Humerus	0.535 ± 0.0038	5.41 ± 0.51	0.511 ± 0.0051	5.32 ± 0.71
Femur	0.227 ± 0.0046	14.71 ± 1.46	0.262 ± 0.0089	18.25 ± 2.49
Tarsometatarsus	0.143 ± 0.0019	9.70 ± 0.95	0.130 ± 0.0021	8.60 ± 1.15
	Average length millimeters.		Average length millimeters.	
Humerus	32.19 ± 0.07	1.62 ± 0.15	31.59 ± 0.17	2.94 ± 0.39
Femur	28.60 ± 0.08	1.93 ± 0.19	27.90 ± 0.16	3.04 ± 0.40
Tibiofibula	38.35 ± 0.10	1.93 ± 0.19	37.43 ± 0.23	3.26 ± 0.44
Tarsometatarsus	21.19 ± 0.06	2.12 ± 0.21	20.43 ± 0.16	4.07 ± 0.54
Basion-spine sphenoid	8.27 ± 0.08	2.88 ± 0.28	7.91 ± 0.08	5.14 ± 0.68
Occiput-hinge	26.32 ± 0.11	3.07 ± 0.29	25.77 ± 0.14	2.86 ± 0.38
Bitemporal width	16.05 ± 0.04	1.77 ± 0.17	15.77 ± 0.08	2.81 ± 0.37
Sternal length	53.22 ± 0.27	3.55 ± 0.35	51.24 ± 0.26	2.60 ± 0.36
Sternal height	20.65 ± 0.12	4.24 ± 0.40	19.96 ± 0.12	3.11 ± 0.41

sult. On the other hand, the bitemporal diameter marks the maximum width of the brain case, and its width is much more significant.

In these skulls the bitemporal or skull width is the most constant of the twelve dimensions of the skull. The skull height is next and the skull length the most variable of these three. As shown in figure 1 (S. L.) the skull length includes the length of the brain case and the length of the beak. The dimension which more nearly gives the length of the brain case and is also comparable to the measurement of Schneider and Dunn ('24) in the chicken skull is the occiput-hinge dimension (O. H. in fig. 1) which has a coefficient of variation of 3.12 percent, or a lower coefficient than the skull height, but still greater than the transverse or bitemporal diameter. Thus the greater variability of the total skull length seems to be in the beak. The dove skull with a more constant width, or bitemporal diameter, resembles the skulls of the turkey (Latimer and Rosenbaum, '26), chicken (Schneider and Dunn, '24), muskrat (Latimer and Riley, '34) and the mouse, *Mus musculus* (Green, '32). In the following forms the skull length has been found to be more constant: the skunk (Latimer, '37), the mouse, *Mus bactrianus* (Green, '32) and the human skull (Duckworth, '17; Orensteen, '15 and '20; Pearson and Davin, '24, and others).

In general, the lengths of the six long bones are less variable than the twelve linear dimensions of the skull. The skull width is less variable than any of the other dimensions of the skull, with both the skull height and length more variable and in this order. The average coefficient of variation for the twelve dimensions indicates that the skull of the mourning dove is more variable than that of the other bird skulls studied, and for the skunk (Latimer, '37), and yet, it is less variable than for many mammal skulls.

The last column in table 1 gives the significant difference between the weights and lengths in the male and female doves. This significant ratio is the difference between the average measurements of male and female divided by the probable error of this difference. This shows that only three of the seven weights are significantly heavier in the males, and nine of the twenty-two linear dimensions. In every case the weights and linear measurements were somewhat greater in the males. No difference for the wingspread was determined, for there were only five of each sex and it was felt that this number was not large enough to warrant any conclusions. The numbers of the specimens for these computations are not as large as they should be, but the results would indicate that the mourning dove does not show any very marked sex differences.

TABLE 3

A. Correlations with skull weight. All weights in grams

Humerus	+ 0.487 ± 0.082		
Radius	+ 0.544 ± 0.076		
Ulna	+ 0.486 ± 0.085		
Femur	+ 0.322 ± 0.098		
Tibiofibula	+ 0.381 ± 0.095		
Tarsometatarsus	+ 0.619 ± 0.068		

B. Linear correlations. All lengths in millimeters

	Skull length.	Skull height.	Bitemporal.
Humerus	+ 0.155 ± 0.104	+ 0.296 ± 0.100	+ 0.388 ± 0.091
Radius	+ 0.221 ± 0.101	+ 0.317 ± 0.098	+ 0.546 ± 0.075
Ulna	+ 0.263 ± 0.102	+ 0.230 ± 0.106	+ 0.657 ± 0.062
Femur	+ 0.269 ± 0.100	+ 0.308 ± 0.100	+ 0.492 ± 0.082
Tibiofibula	+ 0.363 ± 0.095	+ 0.310 ± 0.102	+ 0.576 ± 0.073
Tarsometatarsus	+ 0.394 ± 0.091	+ 0.376 ± 0.095	+ 0 477 ± 0.083
Basion-occiput	— 0.431 ± 0.088	+ 0.021 ± 0.109	+ 0.085 ± 0.107
Basion-spine sphenoid	+ 0.185 ± 0.106	+ 0.342 ± 0.098	+ 0.450 ± 0.087
Spine sphenoid-tip beak	+ 0.368 ± 0.093	+ 0.183 ± 0.107	+ 0.770 ± 0.044
Occiput-hinge	+ 0.325 ± 0.095	+ 0.345 ± 0.096	+ 0.529 ± 0.077
Hinge-tip of beak	+ 0.369 ± 0.092	+ 0.073 ± 0.109	+ 0.086 ± 0.106
Mandible	+ 0.481 ± 0.084	+ 0.275 ± 0.105	+ 0.248 ± 0.104
Skull height	+ 0.157 ± 0.107	....	+ 0.304 ± 0.099
Bitemporal width	+ 0.152 ± 0.104	+ 0.304 ± 0.099	....
Interorbital width	+ 0.339 ± 0.094	+ 0.393 ± 0.092	+ 0.475 ± 0.083
Foramen magnum length	— 0.126 ± 0.109	+ 0.274 ± 0.103	— 0.088 ± 0.110
Foramen magnum width	— 0.043 ± 0.106	+ 0.008 ± 0.109	+ 0.232 ± 0.101
Sternal length	+ 0.282 ± 0.102	+ 0.316 ± 0.103	+ 0.365 ± 0.096
Sternal height	+ 0.323 ± 0.097	+ 0.171 ± 0.108	+ 0.435 ± 0.088
Interacetabular width	+ 0.104 ± 0.107	+ 0.272 ± 0.103	+ 0.545 ± 0.076
Total length	+ 0.381 ± 0.095	+ 0.318 ± 0.102	+ 0.447 ± 0.087
Wingspread	+ 0.659 ± 0.121	+ 0.463 ± 0.177	+ 0.168 ± 0.207

Table 2 gives the averages and the coefficients of variation for males and females for those measurements in which there is indicated a significant sex difference in table 1. In every case the male measurements are greater than the female. In addition this table shows that the females are more variable on the average. The average coefficient of variation for all of these twelve measurements is 4.41 percent for the males and 5.17 percent for the females or 17 percent more variable. The weights alone are 7.85 percent more variable in the females and the linear dimensions are 28.79 percent greater.

CORRELATIONS

In order to determine how well the weight and linear dimensions of the skull represent the other measurements of the skeleton, the skull weight was first correlated with the weights of the six long bones and given in the first part of table 3. The correlations be-

tween the skull length and the other linear dimensions are given in the first column of the second part of table 3. These were so low that two other skull measurements, namely skull height and bitemporal width or skull width, were correlated with the linear dimensions and these correlations are given in the last two columns of the second part of this table.

TABLE 4

Asymmetry in weight and length of the paired bones

The heavier or longer bone, or bones of equal size, are given in terms of percentage of the total number of each bone, which is given in the second column.

WEIGHTS.	Number of bones.	Right greater.	Left greater.	Same.
Humerus	33	42.4	48.5	9.1
Radius	35	42.8	42.8	14.4
Ulna	29	41.4	51.7	6.9
Femur	32	37.5	53.1	9.4
Tibiofibula	32	59.4	31.2	9.4
Tarsometatarsus	37	29.7	48.6	21.7
LENGTHS.				
Humerus	33	30.3	30.3	39.4
Radius	35	40.0	34.3	25.7
Ulna	29	37.9	34.5	27.6
Femur	32	28.1	28.1	43.8
Tibiofibula	32	43.8	31 2	25.0
Tarsometatarsus	36	27.8	27.8	44.4

The correlations of the weights of the six long bones with skull weight give an average correlation of + 0.473. The similar average correlation for the muskrat and the skunk both are above + 0.8. We may conclude that the skull weight of the dove is not nearly as good a criterion of the weights of the long bones as in the two species of mammals. The average of the skull length correlated with all of the linear dimensions is + 0.236, the similar correlation with the skull height is + 0.266 and with the skull width, + 0.390. The average correlations of the skull dimensions alone with the skull length is + 0.161, with skull height, + 0.222 and with bitemporal width, + 0.309. Thus it is evident that each of these dimensions of the skull gives better average correlations with the lengths of the six long bones and the other five dimensions than with the other dimensions of the skull. The only one of these averages over + 0.5 is that with the skull width and lengths of the six long bones, or + 0.523. In the muskrat the average correlations of skull length and the other dimensions of the skull and the lengths of the long bones both averaged above + 0.7 and in the skunk the similar correlations were slightly lower, but all far above the similar correla-

tions in the mourning dove. Green ('33) finds some low and even negative correlations with the skull length in the mouse. The wing-spread is the only dimension which has a correlation above 0.5 percent when correlated with the skull length. Not one of the twenty-one dimensions gives a correlation above 0.5 percent when they are correlated with skull height. When these dimensions are correlated with bitemporal width there are six correlations above 0.5 percent. It has been shown above that the variability of the dove, while it is greater on the average than that in some other birds, is lower than that of both the skunk and the muskrat and yet the correlations are much higher in both of these mammals. This would lead to the conclusion that while there seems to be but little variation in the same dimensions as measured in various doves, the relative proportions of the dove are not as constant as in some of the mammals.

In the skunk (Latimer, '37) the length of the foramen magnum had a low correlation with skull length and so in this study both the length and the width of the foramen magnum were measured, and as shown in table 3 both of these dimensions when correlated with either skull length, height, or width give very low correlations which are not significant in any case. To see whether there was any uniformity in the two diameters of the foramen magnum its length and width were correlated with the resulting correlation of $+ 0.178 \pm 0.107$. This means that not only are the two dimensions of the foramen magnum not correlated with the three skull dimensions, but that they bear little relationship to each other.

The length from the occiput to the anterior border of the foramen magnum or basion-occiput (fig. 1) shows low correlations with all three of the skull dimensions and so it was correlated with the measurement from the basion to the tip of the spine of the sphenoid. This should give some idea of the variability of the occipital condyle with reference to the two ends of the basilar surface of the skull. The correlation between the basion-occiput and the basion to the spine of the sphenoid (fig. 1) was -0.345 ± 0.096, or a non-significant negative correlation.

From the above correlations we would judge that neither the weight of the mourning dove skull, nor the skull length, skull height, or the skull width are good criteria of the weights or lengths of the long bones or of the other dimensions of the skull. Of the three dimensions, the skull width or the bitemporal diameter is the best criterion of the other linear measurements, and it is on the

average better correlated with the lengths of the long bones than with the other skull dimensions.

SYMMETRY

As has been stated above, each of the paired bones was weighed and measured separately. In the preceding tables the sum of the weights of the two bones and the averages of the lengths have been used. In table 4 we have listed the number of complete pairs of bones in the second column. Where one bone was broken the weight of the one normal bone was doubled and its length was used for the data in tables 1-3, and so the numbers given in the second column of table 4 are less than in the preceding tables. The percentage frequency of a heavier or longer right bone, or left bone or bones of the same weight or length, are given rather than the absolute numbers, which can easily be obtained from the total number of pairs of bones.

In no case do we find a percentage of 60 percent, and only three times is there a percentage of over 50 percent in the weights, and the highest percentage in the linear dimensions is 43.8 percent for the right tibiofibula and for the femur. Four pairs of the bones are heavier on the left side a little more frequently, but three pairs of the six bones are longer a little more frequently on the left side. The percentages in all cases are so low that it seems to be very questionable whether there is any dominance of either side in either weight or length of these six pairs of long bones.

SUMMARY

The weights of the skull and of the six pairs of long bones have the highest average coefficient of variation, followed by the average of the twelve dimensions of the skull. The lengths of the long bones are the least variable. The skull width is the most constant dimension of the skull.

A significant sex difference is indicated for but few of the weights and linear measurements. Where there is a significant sex difference, the females are more variable in both weight and length.

Only two of the correlations of the weights of the long bones and the skull weight are significant. The correlations of the linear dimensions show that the skull width, or the bitemporal diameter, is the best criterion of the other linear dimensions. This is followed by the skull height, and the lowest correlations are between the skull length and the other linear dimensions. The low correlations for

both the weights and the linear dimensions would indicate that the skull weight and the three linear dimensions of the skull are not good criteria of the other weights and lengths.

There does not seem to be any significant asymmetry in the weights or in the lengths of the paired bones.

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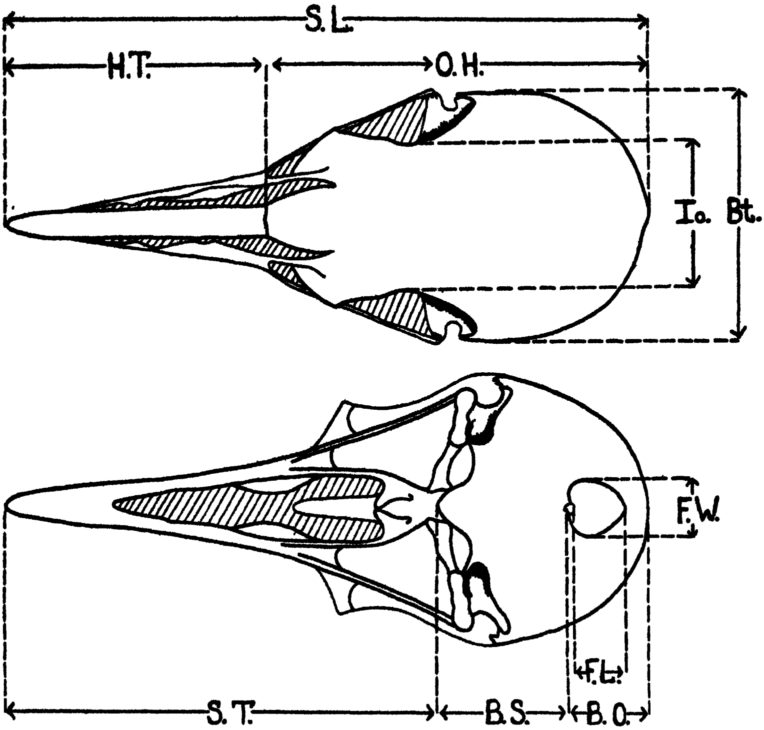

FIG. 1. Drawing of the dorsal side of the skull in upper part and lower side in lower part, showing the ten dimensions measured.

EXPLANATION OF FIGURE

S. L., Skull length	S.T., Spine sphenoid-tip of beak
H.T., Hinge-tip of beak	B.S., Basion-spine of sphenoid
O.H., Occiput-hinge	B.O., Basion-occiput
Bt., Bitemporal width	F.L., Length foramen magnum
Io Interorbital width	F.W., Width foramen magnum

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Weights and Linear Dimensions of the Skull and of Some of the Long Bones of the Red-tailed Hawk (*Buteo borealis borealis*)

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ABSTRACT: The skull and six long bones of twenty-four male and 27 female hawk skeletons were weighed. Fourteen skull dimensions and twenty-one dimensions of the long bones were made.

The weights and linear dimensions are as a rule more variable in the males. The skull height is the most constant dimension in both sexes. Both skull weight and skull length are fairly constant and their coefficients are less variable than the average of the coefficients of variation.

The weights of the skull, the mandible and the six long bones are all significantly heavier in the females. All of the thirty-seven linear dimensions are greater in the females and most are significantly greater.

The weights and the linear dimensions are as a rule better correlated with skull weight and skull length in the females. The skull weight is better correlated with all of the weights than is the skull length, but the skull length is better correlated with most of the linear dimensions. In the females, the skull length is better correlated with the longitudinal dimensions of the skull and the skull weight is better correlated with the transverse dimensions.

The frequency of heavier or longer members of the paired bones is given. The asymmetries are not great enough to justify the conclusion that there is anything but normal variation in a normal bilateral symmetry.

THE literature contains very few quantitative studies of the avian skeleton, and so it has seemed best to utilize these skeletons which have been so well prepared, even though the numbers are not as large as could be desired. This paper will give the average measurements of the weights and of the linear dimensions of the skull and of some of the long bones of the male and the female hawk skeletons. Then the degree of dispersion of these measurements will be given and this should show how reliable the various measurements are for taxonomic studies. The sex differences will be presented

next. Next the correlations between the skull weight and the skull length and the other measurements of the skull and of the long bones will be presented. These correlations should give some idea of the validity of using skull weight or skull length as general criteria for the other skeletal measurements. Last of all the asymmetry of the paired bones will be discussed very briefly. This follows the general plan employed in the two earlier papers on mammalian skeletons, or the muskrat (Latimer and Riley, '34), and the skunk (Latimer, '37), and in the study of the skeleton of the mourning dove (Latimer and Asling, '38).

This collection of hawk skeletons, like the collections used in the preparation of the preceding papers, is from the Natural History Museum of the University of Kansas. All of the bones of all four species of animals have been prepared in the same manner. This collection is not as large as the two mammalian collections, nor as large as could be desired for final conclusions, but it is hoped that, together with the preceding paper on the mourning dove skeleton, it will contribute to the knowledge of the bird skeleton. Linsdale ('30) has made an excellent study of a series of 465 skeletons of several subspecies of the fox sparrow. The skeletons of the road-runner (Larson, '31) and of several species of woodpeckers (Burt, '31) have been studied quantitatively, but this is the only study of this kind, so far as is known, on the skeleton of any hawk.

MATERIALS AND METHODS

The skeletons of fifty-one adult red-tailed hawks were studied. Of these, twenty-four were males and twenty-seven females. A few of the skeletons were injured in one or more bones or were slightly incomplete, so the weights of the entire skeletons could not be obtained. As many weights and measurements as possible were made on each skeleton, and with the exception of the total body length and the wingspread, the numbers of each measurement are complete or are only a few short of the full number. The total body length and the wingspread were recorded on the slip with each skeleton and were made by the museum staff and were found in only a little over half of the specimens.

All of the skeletons, packed in individual pasteboard boxes, were kept in a dry room for some time before weighing, but the bones were not oven dried. The weights were made on a chemical balance sensitive to 0.1 milligram, but the weights were taken only to the nearest milligram. In weighing and in measuring the paired bones, the bone of the pair which was picked up first was weighed or

measured first to avoid a definite sequence and a possible bias in making the measurements. The weights of the paired bones in tables 1 and 2 are the sum of the weights of the right and left bones. The skull weight does not include the weight of the mandible.

All of the linear measurements were made with a vernier caliper reading to 0.1 millimeter, and the dimensions of the paired bones in tables 1 and 2 are the average of the right and left bones of each pair. The methods used in making twelve of the dimensions of the skull are illustrated in figure 1. The skull height was made with the arm of the caliper parallel to and against the base of the skull with the back of the caliper against the occiput, and the moveable arm was carefully slipped down until it touched the top of the skull. The length of the mandible was measured from the tip of the mandible to the most posterior part of the left side, with the back of the caliper parallel to the left side of the mandible.

The lengths of the long bones were all made with the long axis of the bone held parallel to the back of the caliper and the maximum length taken. The widths of both the proximal and the distal ends of the humerus, the femur and the tibiofibula are the maximum widths and they were made with the bone held with its long axis parallel to the arms of the caliper. The diameters of the shafts are the minimum anteroposterior diameters. The diameter of the head of the femur is the maximum anteroposterior diameter. The length of the scapula is the maximum length and the width is likewise the maximum width. The length of the sternum is the maximum length in the midline, and the height was measured from the superior or inner side of the bone to the free border of the keel, with the back of the caliper held parallel to the anterior border of the keel. A caliper with curved arms was used in making this measurement which is largely the maximum height of the keel of the sternum plus the thickness of the body of the sternum at the union of the body and keel. The interacetabular diameter is the minimum diameter from the dorsal sides of the rims of the two acetabula. The "acetabulum-crest ilium" is the minimum distance from the rim of the acetabulum to the crest of the ilium, and the width of the ischium is the maximum diameter, including both right and left ischia.

The formulae used in making the computations are those usually so employed and are given by Dunn ('29). All of the statistical work was checked and all of the figures were carried to at least one and usually two or three more decimal places than those given in the tables.

I wish to express my most sincere appreciation to Mr. C. D. Bunker for permitting the use of this excellently prepared collection of skeletons, and to Mrs. Mary M. White for assistance in making the linear measurements, and to Miss Edna Mae McConnell for making the weighings and for her careful help with the statistical work.

AVERAGES AND VARIABILITY

The average measurements of both the weights and the lengths and their coefficients of variation for both the males and the females are given in table 1. These coefficients of variation of the hawk skeleton have a higher average coefficient in the males, just as has been found in the skunk skeleton (Latimer, '37), and in the external dimensions of the cat (Latimer, '36). The average coefficient of variation for the eight weights is 13.95 for the males and 13.42 for the females, or a difference of 3.76 percent. The average of the coefficients of the fourteen linear dimensions of the skull is likewise greater in the males, or 4.93 percent for the males and 4.84 percent for the females, or the averages are 1.64 percent greater in the males. The greatest difference is found in the last twenty-three dimensions in this table with an average coefficient of variation of 5.37 for the males and an average of 5.11 for the females, or a difference of 6.63 percent. As is to be expected, the weights are more variable than the linear dimensions. The dimensions of the skull are in general less variable than are the other linear measurements, and of the skull dimensions the skull height is the most constant in both sexes. The skull length is less variable than any of the last twenty-three dimensions in both sexes, and of the skull dimensions in the male only four are less variable than the skull length and but three in the female. This would show that the skull height and, to a lesser degree, the skull length, are constant and fairly reliable dimensions.

The longitudinal measurements of the skull and of the long bones are less variable on the average than are the transverse dimensions. The length from the basion to the occiput (B.O. in figure 1) does not seem to be a constant measurement in the hawk or in the mourning dove, for it was the most variable of the skull dimensions in the dove and also the most variable in the male hawk and second most variable in the female hawk. The interorbital and the binasal diameters are also variable. They are the two most variable dimensions in the female and the second and third in rate of variability in the male hawk. Both of these measurements are made from the

thin edges of the bone. The central portions of these bones provide adequate strength and the thin edges may vary without making any significant difference. These are rather unreliable measurements. The edges of the bone bordering the orbits, especially, show irregularities which would make this dimension variable. The two diameters of the foramen magnum in the hawk skull are fairly constant.

The greater variability in the transverse dimensions of the long bones may, in a measure, be accounted for by the greater difficulty in making these measurements and because of their smaller size. This would not explain the variability of the width of the skull. In the females, the proximal bone of each appendage is less variable in weight and in length, with the exception of the ulna, than the more distal bones in the same extremity. This is not true for the males, however. The ulna is the most constant in weight of all the bones in the males and the humerus in the females. The three wing bones are less variable in the males than the three bones of the lower extremity, and this is also true for the females if the average variability of the three bones in each extremity is considered. The mandible is the most variable in weight in the males and in the females the tibiofibula is the most variable in weight. The measurements of the total length and the wingspread have high coefficients of variation.

A comparison of these coefficients of variation with similar coefficients of the other skeletons studied shows that the variability of these measurements in the hawk is about the same as that found in the two mammalian skeletons and the one bird skeleton. The hawk skull is about as variable as that of the fox sparrow, but the lengths of the long bones seem to be more variable in the hawk than in the fox sparrow (Linsdale, '30).

The last column of table 1 gives the significant ratios, or the difference between the average measurements of the female and the male divided by the probable error of this difference. The greatest differences are in the weights and all of these are significantly heavier in the females. The greatest sex differences seem to be in the weights of the three wing bones. Of the next fourteen linear dimensions of the skull five, or 35.71 percent, are not significantly greater in the females. Table 1 shows the basion-occiput length the same in both sexes, but in computing these ratios the figures used were the figures before they were rounded out and cut to but one decimal place. The average lengths of the basion-occiput with three decimal places are 9.207 for the female and 9.190 for the male, thus making this dimension slightly greater in the female and giving a ratio of

0.10, as shown in the last column of this table. Only three of the last twenty-three dimensions do not show a significant sex difference, and one of these, namely the scapula width, is nearly great enough to conclude that there is very probably a real sex difference in the width of the scapula in the two sexes.

All of the weights and the linear dimensions of the male and the female hawks were plotted as frequency polygons (not shown for lack of room). Fifty-six percent of these polygons in each sex were skewed toward the smaller measurements. The remainder were skewed chiefly toward the greater measurements. A very few were symmetrical.

In general it may be said that the dimensions of these bones are fairly constant as compared with other animal skeletons. The greater variability is found in the male skeletons. The skull weight, length and height are all more constant than the average of the other coefficients for each group. The skull height is the most constant dimension of the skull in both sexes, and is also more constant than any of the other linear dimensions. All of the weights are significantly heavier in the females, and all of the linear dimensions are greater in the females and the majority of these are significantly greater.

CORRELATIONS

The correlations of the eight weights and the thirty-seven linear dimensions with skull weight and with skull length for both males and females are given in table 2. It has been shown in table 1 that the weights and the linear dimensions are in general more variable in the male hawks, and this table shows that the weights, the linear dimensions of the skull and the other group of linear dimensions all have higher average correlations with both skull weight and skull length in the females. The only exceptions in the correlations of the weights are the weight of the radius with skull length and the weight of the femur with skull weight. There are several exceptions in the linear dimensions, and most of these are correlations with skull length. In general the males are more variable and the skull weight and the skull length are not as well correlated with the other weights and linear dimensions as in the female hawks.

The averages of the correlations of the eight ponderal measurements show that they are better correlated with skull weight than with skull length in both sexes. The last twenty-three dimensions in table 2 have a higher average correlation with the skull length in both the males and the females. In the male hawks, the skull length

has a higher average correlation with the fourteen linear dimensions of the skull, but in the females the averages of the correlations are practically the same with both skull weight and skull length.

The last group of twenty-one linear measurements, omitting the last two, which are not skeletal dimensions, consists of two different types of measurements, namely, those parallel to the long axes of the bones and those perpendicular to the long axes, or measurements of length and measurements of the thickness or of the strength of the bones. The question arose as to whether the skull weight would be found to be better correlated with the transverse diameters and the skull length with the longitudinal dimensions. The averages of these two types of dimensions show that in the males the skull length has a higher average correlation with both the longitudinal and the transverse measurements of the long bones and also higher average correlations with both the longitudinal and the transverse dimensions of the skull. Hence in the male hawk the skull length is in general a better criterion of all of the linear dimensions than is the skull weight. In the female hawks the skull length is better correlated with the seven linear dimensions of the skull and the skull weight is better correlated with the six widths of the skull. The averages of the correlations of the ten longitudinal measurements and the eleven transverse dimensions in the last twenty-one dimensions of this table, with both skull weight and skull length in the females, show little difference. Thus the skull weight and the skull length are nearly equally good indices of both the longitudinal and the transverse dimensions in the female hawks.

All of the correlations in the female skeletons are positive, but some are so low that they are not significant. All but one of the male weights are positive when correlated with either skull weight or skull length. Six of the linear correlations in the males are negative, three of these are correlations with skull weight and three different dimensions are correlated with skull length. None of these negative correlations are significant and all but one have larger probable errors than the correlation itself. The highest of the correlations with the weights is $+0.874$ for the female skull weight correlated with the weight of the humerus. The highest correlation in this table is $+0.929$ and it is found between the male skull length and the length from the end of the palatine bone to the tip of the beak. The highest correlation in the female is this same dimension correlated with skull length. Although this dimension (P.T. in figure 1) forms a relatively large proportion of the total skull length, the point used as the posterior end of this measurement must be fairly

constant and also the length of the beak. In the mourning dove skull (Latimer and Asling, '38) the beak was found to be quite variable, but this measurement in the hawk, which includes the length of the beak, has a coefficient of variation of but 3.86 in the males and 3.91 in the females (table 1).

If the averages of the correlations for the various groups of correlations in table 2 are compared with similar average correlations given in the other two papers on the mammalian skeletons, these averages are lower, indicating that these measurements of the skull in the hawk are not as good criteria of the other measurements as are the similar skull dimensions in the muskrat and in the skunk, but they are much better than the similar averages for the dove skeleton. The skull lengths in the male hawks have the lowest averages of any of the groups, or + 0.241 when correlated with skull weight and + 0.478 when correlated with skull length. The next lowest are the other linear dimensions in the males (last 23 correlations in table 2), which when correlated with skull weight have an average correlation of + 0.425 and a correlation of + 0.487 when correlated with skull length. All of the other groups of linear dimensions have average correlations above + 0.5 in both the males and the females. The weights in the males when correlated with skull weight have an average correlation of + 0.595, and + 0.446 when correlated with skull length. Similar correlations in the females are, respectively, + 0.741 and + 0.587. These correlations would show that in the two avian forms studied the skull weight or the linear dimensions of the skull are not as good criteria of the weights and the linear dimensions of the other parts of the skull and of the other bones of the skeleton as they are in the two mammals studied.

In general, the correlations with both skull weight and skull length are higher in the females. The skull weight gives higher correlations with the other weights and in the males the skull length is a better criterion of all of the linear dimensions, both longitudinal and transverse, than is the skull weight. In the females, the skull length is better correlated with the other seven longitudinal dimensions of the skull and the skull weight is better correlated with the six transverse dimensions.

ASYMMETRY

The right and the left bones of each pair were weighed and measured separately as described above and the sum of the weights or the average of the lengths of each pair given in tables 1 and 2. In table 3 the number of pairs of bones is given in the second column

and the following columns give the percentage frequency of a heavier or longer right bone, a heavier or longer left bone, or bones of equal weight or of equal length. This table shows a greater asymmetry in the bones of the hawk than is shown for the mourning dove skeleton (Latimer and Asling, '38). The humerus and radius are both heavier more frequently on the right side and the three bones of the lower extremity are heavier more frequently on the left side, suggesting a crossed symmetry (Schaeffer, '28) for a bird which does not use the two pairs of extremities at the same time or for the same method of locomotion. The second part of this table shows that the lengths of the paired bones of both the wing and the leg are longer more frequently on the right side, the lengths of the scapula and the coracoid alone being greater more frequently on the left side.

In general, the hawk shows a greater asymmetry in both weight and in length of the long bones of the extremities than does the mourning dove. In degree of asymmetry it resembles the three mammals studied, and like the other skeletons there seems to be no significant type of asymmetry, but probably merely a fortuitous variation. These variations are frequently so small that they would not be functionally significant. According to Grüneberg ('35) these asymmetries are a common type and they are "caused directly through the asymmetrical interference of environmental factors with the action of equally distributed genes on a symmetrical substratum."

SUMMARY

The weights and the linear dimensions are as a rule more variable in the males. The skull height is the most constant linear dimension in both sexes. Both skull weight and skull length are fairly constant and the coefficients of both are less variable than the average of the coefficients of variation.

The weights of the skull, mandible and the six long bones are all significantly heavier in the female hawks. All of the thirty-seven linear dimensions are greater in the females and most of these are significantly greater.

The weights and the linear dimensions are as a rule better correlated with skull weight and with skull length in the female hawks. The skull weight is better correlated with all of the weights than is the skull length, but the skull length is better correlated with most of the linear dimensions. In the females, the skull length is better correlated with the longitudinal dimensions of the skull and the skull weight is better correlated with the transverse dimensions.

The frequency of a heavier or a longer member of the paired bones is given. A crossed symmetry seems to be apparent for the weights of the humerus and the femur, but the lengths of all of the six long bones of the two extremities are greater more frequently on the right side. None of the percentages are probably great enough to warrant the conclusion that there is anything but normal variations in a normal bilateral symmetry.

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TABLE 1

Average measurements, coefficients of variation and significant ratios

	Males.		Females.		Difference
	Average weight in grams.	Coefficient of variation.	Average weight in grams.	Coefficient of variation.	P. E. diff.
Skull	5 195 ± 0.110	13 31 ± 1 52	6 070 ± 0 098	12 17 ± 1.15	5 94
Mandible	1 049 ± 0.027	17 58 ± 1 93	1 250 ± 0 024	14.29 ± 1 36	5 57
Humerus	7 635 ± 0 130	11 61 ± 1 25	9 518 ± 0 127	10.30 ± 0.96	10 36
Radius	2.307 ± 0 036	10 67 ± 1 15	3 099 ± 0 052	12 72 ± 1 21	12 52
Ulna	6 556 ± 0 108	10 60 ± 1 17	9 201 ± 0 173	14 47 ± 1 33	12.97
Femur	5 353 ± 0 154	18 62 ± 2.11	6 551 ± 0 104	12 05 ± 1 14	6 45
Tibiofibula	8 017 ± 0 175	14 83 ± 1 62	10.139 ± 0.217	16 15 ± 1 55	7 61
Tarsometatarsus	5 627 ± 0 119	14 36 ± 1.56	7 331 ± 0 145	15 24 ± 1 43	9 08
	Average length in millimeters.		Average length in millimeters.		
Skull length	78 3 ± 0 37	3 21 ± 0 34	80 8 ± 0 36	3 40 ± 0 31	4 85
Skull height	31 8 ± 0 10	2 02 ± 0 22	32 3 ± 0 10	2 34 ± 0 21	3 52
Basion-occiput	9 2 ± 0 15	10 37 ± 1 15	9 2 ± 0 08	6 60 ± 0 61	0 10
Basion-palatine	19 5 ± 0 17	5 49 ± 0 62	20 1 ± 0 15	5 55 ± 0 51	2.52
Palatine-tip of beak	49 6 ± 0 30	3 86 ± 0 42	51 5 ± 0 26	3 91 ± 0 36	4.94
Occiput-nasals	55 5 ± 0 24	2 98 ± 0 32	56 6 ± 0 18	2 41 ± 0 22	3 86
Mandible, length	61 9 ± 0 33	3 59 ± 0 38	64 3 ± 0 36	4 32 ± 0 40	4 75
Bitemporal width	49 1 ± 0 18	2 52 ± 0 27	51 0 ± 0 19	2 76 ± 0 26	7 55
Interorbital width	17.9 ± 0 26	9 79 ± 1 05	18 3 ± 0 20	8 28 ± 0 77	1 36
Bilacrymal width	45 9 ± 0 43	5 31 ± 0 66	47 0 ± 0 35	5 15 ± 0 53	1 87
Binasal width	5 0 ± 0 06	8 34 ± 0 90	5 8 ± 0 08	10 97 ± 1 02	7 36
Biauditory width	41 6 ± 0 17	2 85 ± 0 30	43 7 ± 0 20	3 47 ± 0 33	7 71
Foramen magnum length	7 3 ± 0 05	4 90 ± 0 53	7 3 ± 0 04	4 71 ± 0 43	0 50
Foramen magnum width	8 6 ± 0 05	3 82 ± 0 41	8 8 ± 0 05	3 94 ± 0 36	3 16
Humerus, length	106 9 ± 0 65	4 13 ± 0 44	113 5 ± 0 51	3 49 ± 0 31	7 94
Humerus, width proximal end	24 0 ± 0 13	3 81 ± 0 41	25 7 ± 0 15	4 62 ± 0 43	8 35
Humerus, anteroposterior diam.	7 1 ± 0 05	4 66 ± 0 50	7 6 ± 0 05	5 06 ± 0 47	6 33
Humerus, width distal end	18 7 ± 0 12	4 45 ± 0 48	20 0 ± 0 12	4 49 ± 0 41	7 88
Radius, length	111 5 ± 1 09	6 65 ± 0 71	124 5 ± 0 59	3 64 ± 0 33	10 45
Ulna, length	124 8 ± 0 79	4 10 ± 0 45	131 8 ± 0 59	3 47 ± 0 32	7 07
Femur, length	82.1 ± 0 50	3 90 ± 0 43	85 9 ± 0 41	3 62 ± 0 34	5 86
Femur, diameter of head	6 7 ± 0 06	5 81 ± 0 62	7 2 ± 0 06	5 93 ± 0 55	5 95
Femur, anteroposterior diam	7 6 ± 0 07	5 58 ± 0 61	8 4 ± 0 07	6 15 ± 0 57	8 51
Femur, width distal end	17 1 ± 0 15	5 89 ± 0 63	18 7 ± 0 14	5 57 ± 0 51	8 10
Tibiofibula, length	109 8 ± 0 62	3 83 ± 0 41	115 3 ± 0 57	3 71 ± 0 35	6 55
Tibiofibula, width distal end.	13 6 ± 0 10	4 82 ± 0 52	14 9 ± 0 12	6 48 ± 0 60	7 79
Tarsometatarsus, length	82 3 ± 0 52	4 28 ± 0 46	84 9 ± 0 45	4 12 ± 0 38	3 80
Scapula, length	60 4 ± 0 38	4 35 ± 0 47	63 7 ± 0 37	4.46 ± 0 41	6 25
Scapula, width	8 6 ± 0 07	5 61 ± 0 60	9 3 ± 0 08	6 80 ± 0 63	2 50
Coracoid length	45 5 ± 0 41	6 06 ± 0 63	48 6 ± 0 29	4 62 ± 0 42	6 08
Sternal length	68 7 ± 0 61	6 03 ± 0 65	73 1 ± 0 51	5 34 ± 0 49	5.50
Sternal height	19 2 ± 0 19	6 70 ± 0 72	20 5 ± 0 15	5 52 ± 0 51	5 34
Interacetabular diameter	26 0 ± 0 30	7 95 ± 0 85	26 8 ± 0 16	4 53 ± 0 42	2 27
Acetabulum-crest of ilium.	40 9 ± 0 29	4 82 ± 0 52	43 8 ± 0 23	3 98 ± 0.37	8 04
Ischium, width	39 3 ± 0 30	5 14 ± 0 55	41 5 ± 0 31	5 76 ± 0 53	4 98
Total length	552.2 ± 6 86	7.59 ± 0 91	562 3 ± 3.13	4.20 ± 0 39	1.34
Wingspread	376 8 ± 5 55	7 24 ± 1 05	411.3 ± 9.29	12 08 ± 1.62	3.19

TABLE 2

Correlations

	Males.		Females.	
WEIGHTS. (All weights in grams).	Correlations with skull weight.	Correlations with skull length.	Correlations with skull weight.	Correlations with skull length.
Skull	....	+ 0 307 ± 0 133	....	+ 0.616 ± 0 082
Mandible	+ 0.547 ± 0 103	+ 0.639 ± 0 083	+ 0 812 ± 0 045	+ 0 660 ± 0 075
Humerus	+ 0.676 ± 0 080	+ 0 665 ± 0 078	+ 0 874 ± 0 031	+ 0 639 ± 0.077
Radius	+ 0 367 ± 0.127	+ 0 398 ± 0 118	+ 0.808 ± 0 048	+ 0.533 ± 0 095
Ulna	+ 0 575 ± 0 101	— 0.118 ± 0 142	+ 0 419 ± 0 109	+ 0 336 ± 0 115
Femur	+ 0 594 ± 0 098	+ 0 467 ± 0 112	+ 0 812 ± 0 047	+ 0.635 ± 0 079
Tibiofibula	+ 0.711 ± 0 073	+ 0 526 ± 0 102	+ 0 757 ± 0 059	+ 0 638 ± 0 078
Tarsometatarsus	+ 0.697 ± 0 076	+ 0 681 ± 0 075	+ 0 707 ± 0 066	+ 0 638 ± 0.077
LINEAR DIMENSIONS. (All lengths in millimeters).				
Skull length	+ 0.307 ± 0 133	....	+ 0 616 ± 0 082	....
Skull height	+ 0 481 ± 0 120	+ 0 400 ± 0 118	+ 0 700 ± 0 067	+ 0 548 ± 0 091
Basion—occiput	— 0 086 ± 0 146	+ 0 572 ± 0 097	+ 0 094 ± 0 131	+ 0 229 ± 0 123
Basion—palatine	— 0 221 ± 0 140	+ 0 643 ± 0 086	+ 0 100 ± 0 131	+ 0 725 ± 0 062
Palatine—tip of beak	+ 0 534 ± 0.105	+ 0 929 ± 0 020	+ 0 746 ± 0 059	+ 0 907 ± 0 023
Occiput—nasals	+ 0 170 ± 0 143	+ 0 704 ± 0 071	+ 0 626 ± 0 080	+ 0 615 ± 0 081
Mandible, length	+ 0 724 ± 0 070	+ 0 823 ± 0 045	+ 0 842 ± 0 039	+ 0 785 ± 0 050
Bitemporal width	+ 0 254 ± 0 138	+ 0 048 ± 0 140	+ 0 812 ± 0 047	+ 0 682 ± 0 071
Interorbital width	+ 0 280 ± 0 136	+ 0 278 ± 0 130	+ 0 640 ± 0 078	+ 0 430 ± 0 106
Bilacrymal width	— 0 090 ± 0 167	— 0 153 ± 0 160	+ 0 568 ± 0 097	+ 0 481 ± 0 111
Binasal width	+ 0 329 ± 0 131	+ 0 634 ± 0 084	+ 0 590 ± 0 086	+ 0 480 ± 0 100
Biauditory width	+ 0 373 ± 0 127	+ 0 759 ± 0 060	+ 0 573 ± 0 092	+ 0 743 ± 0 059
Foramen magnum length	+ 0 323 ± 0.132	+ 0 173 ± 0 140	+ 0 237 ± 0 125	+ 0 002 ± 0 130
Foramen magnum width	+ 0 045 ± 0.147	+ 0 405 ± 0.118	+ 0.618 ± 0 082	+ 0 515 ± 0 095
Humerus, length	+ 0 285 ± 0 135	+ 0 610 ± 0 088	+ 0 661 ± 0 074	+ 0 640 ± 0 077
Humerus, width proximal end	+ 0 623 ± 0 090	+ 0 209 ± 0 135	+ 0 692 ± 0 069	+ 0 461 ± 0 102
Humerus, anteroposterior diam. shaft	+ 0 743 ± 0 066	+ 0 662 ± 0 079	+ 0 489 ± 0 101	+ 0 505 ± 0 097
Humerus, width distal end	+ 0 608 ± 0 095	+ 0 708 ± 0 070	+ 0 666 ± 0 074	+ 0 640 ± 0 077
Radius, length	+ 0 152 ± 0 144	+ 0 343 ± 0 124	+ 0 678 ± 0 072	+ 0 639 ± 0 077
Ulna, length	+ 0 301 ± 0 137	+ 0 586 ± 0 094	+ 0 642 ± 0 078	+ 0 616 ± 0 081
Femur, length	+ 0 348 ± 0 133	+ 0 523 ± 0 104	+ 0 784 ± 0 053	+ 0 714 ± 0 065
Femur, diameter of head	+ 0 554 ± 0 102	+ 0 464 ± 0 110	+ 0 515 ± 0 097	+ 0 640 ± 0 077
Femur, anteroposterior diam. shaft.	+ 0 686 ± 0 080	+ 0 817 ± 0 048	+ 0 504 ± 0 099	+ 0 576 ± 0 087
Femur, width distal end	+ 0 408 ± 0 123	+ 0 570 ± 0 095	+ 0 705 ± 0 067	+ 0 580 ± 0 085
Tibiofibula length	+ 0 292 ± 0 135	+ 0 637 ± 0 084	+ 0 664 ± 0 075	+ 0 636 ± 0 079
Tibiofibula, width distal end	+ 0 454 ± 0 117	+ 0 573 ± 0 094	+ 0 552 ± 0 092	+ 0 547 ± 0 091
Tarsometatarsus, length	+ 0 384 ± 0 125	+ 0 679 ± 0 076	+ 0 589 ± 0 086	+ 0 691 ± 0 068
Scapula, length	+ 0 296 ± 0 134	+ 0 521 ± 0 102	+ 0 657 ± 0 075	+ 0 728 ± 0 061
Scapula, width	+ 0 243 ± 0 138	+ 0 376 ± 0 121	+ 0 804 ± 0 047	+ 0 546 ± 0 091
Coracoid, length	+ 0 365 ± 0 128	+ 0 493 ± 0 109	+ 0 660 ± 0 075	+ 0 723 ± 0 062
Sternum, length	+ 0 567 ± 0 100	+ 0 630 ± 0 085	+ 0 697 ± 0 068	+ 0 744 ± 0 058
Sternum, height	+ 0 478 ± 0 114	+ 0 507 ± 0 104	+ 0 511 ± 0 098	+ 0 540 ± 0 092
Interacetabular diameter	+ 0 379 ± 0 126	— 0 022 ± 0 141	+ 0 410 ± 0 110	+ 0 695 ± 0 067
Acetabulum—crest ilium	+ 0 413 ± 0 122	+ 0 470 ± 0 110	+ 0 782 ± 0 051	+ 0 678 ± 0 070
Ischium, width	+ 0 348 ± 0 129	+ 0 687 ± 0 074	+ 0 278 ± 0 122	+ 0 372 ± 0 112
Total length	+ 0 517 ± 0 123	— 0 100 ± 0 157	+ 0 204 ± 0 132	+ 0 595 ± 0 085
Wingspread	+ 0 320 ± 0 202	+ 0 266 ± 0 189	+ 0 116 ± 0 192	+ 0 350 ± 0 164

TABLE 3

Asymmetry in weight and length of the long bones

The heavier or longer right or left bone, or bones of equal size, are given in terms of percentage of the total number of measurements shown in second column.

WEIGHTS.	Number of cases.	Right greater, percent.	Left greater, percent.	Same.
Humerus	50	64.00	36.00	0
Radius	41	51.22	48.78	0
Ulna	40	40.00	60.00	0
Femur	47	46.81	53.19	0
Tibiofibula	46	45.65	54.35	0
Tarsometatarsus	50	46.00	54.00	0
LINEAR MEASUREMENTS.				
Humerus, total length	50	44.00	38.00	18.00
Humerus, width, proximal end	51	50.98	29.41	19.6[illegible]
Humerus, width, distal end	50	36.00	42.00	22.00
Humerus, anterioposterior diameter	50	24.00	28.00	48.00
Radius, total length	41	60.98	26.83	12.19
Ulna, total length	40	72.50	17.50	10.00
Femur, total length	47	48.94	23.40	27.66
Femur, diameter of head	50	22.00	38.00	40.00
Femur, width, distal end	51	50.98	29.41	19.61
Femur, diameter of shaft	49	30.62	32.65	36.73
Tibiofibula, total length	46	56.52	28.26	15.22
Tibiofibula, width, distal end	50	34.00	38.00	28.00
Tarsometatarsus, total length	50	62.00	18.00	20.00
Scapula, length	44	31.82	59.09	9.09
Scapula, width	50	58.00	22.00	20.00
Coracoid, length	47	27.66	51.06	21.28

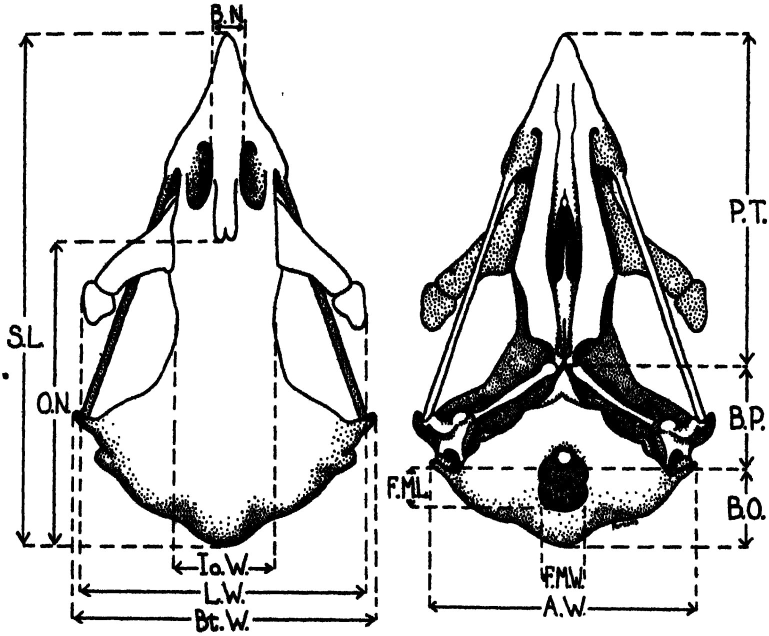

FIG. 1. Drawings of the dorsal and ventral aspects of the hawk skull to show the methods of making the twelve measurements. Two additional measurements were made and they are described in the text.

DESCRIPTION OF THE FIGURE

S.L., Skull length	Io.W., Interorbital width
B. O., Basion-occiput	L.W., Lacrymal width
B.P., Basion-palatine	B.N., Binasal width
P.T., Palatine-tip of beak	A. W., Auditory width
O.N., Occiput-nasals	F.M.W., Foramen magnun width
Bt.W., Bitemporal width	F.M.L., Foramen magnum length

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On the Alkyl Derivatives of the Isomeric Ortho and Para-phenoxyphenyl Thiazolidones

MERRITT ELISHA ROBERTS and F. B. DAINS,
Contribution from the Chemical Laboratory of the University of Kansas

PREVIOUS investigations from this laboratory (1) have shown that the 2-arylamino thiazolidones

$$\overset{1}{S}-\overset{2}{C}(NHR):\overset{3}{N}-\overset{4}{C}O-\overset{5}{C}H_2$$

react with alkyl iodides yielding in varying amounts; (A) the 2-aryl-2-alkyl thiazolidone and (B) the 2-arylimino-3-alkyl thiazolidone.

When the aryl group contained halogen or nitro substituents, there seemed to be a tendency toward the formation of type B. For the present investigation a study has been made of the effect of a phenoxy grouping in both the ortho and para positions, in order to ascertain the influence of this relatively high molar weight radical.

The stable thiazolidones,

$$\overset{1}{S}-\overset{2}{C}(NHC_6H_4OC_6H_5):\overset{3}{N}-\overset{4}{C}O-\overset{5}{C}H_2$$

were prepared by the two following methods: When the monophenoxyphenyl thioureas ($RNHCSNH_2$) from the hydrochloride of phenoxyaniline and ammonium thiocyanate were heated in alcohol solution with ethylchloroacetate, the stable form alone was isolated.

A second preparation was as follows: Phenoxyaniline and chloroacetylchloride in acetone solution gave the omega-chloroacetphenoxyanilide, $ClCH_2CONHC_6H_4OC_6H_5$. When this was heated in ninety-five percent alcohol with potassium thiocyanate, ring closure occurred with the formation again of the stable thiazolidone. Modifying the conditions of this latter case, which will be described later, led to the isolation of the 2-imino or labile form,

$$\overset{1}{S}-\overset{2}{C}(NH):\overset{3}{N}R-\overset{4}{C}O-\overset{5}{C}H_2.$$

The sodium salt of the 2-*p*-phenoxyphenylamino-4-thiazolidone on alkylation gave a mixture of the 2-aryl-2-alkylamino and 2-arylimino-3-alkyl thiazolidones. The ratio of the two isomers formed was twenty-five parts of 2-alkyl to one part of the 3-alkyl derivatives. From the sodium salt of o-phenoxyphenyl-4-thiazolidone the 2-aryl-2-alkyl isomer alone was isolated.

Alkaline hydrolysis caused the ring to break unless it was substituted at position No. 5. Acid hydrolysis left the ring intact, either when substituted or unsubstituted, but hydrolyzed off the phenoxyaniline group at position No. 2.

Methylene reactions could be obtained at position No. 5 using benzaldehydes. Substituted benzaldehydes reacted with greater ease but were apparently less stable.

LABILE THIAZOLIDONES: An especially interesting part of the research had to do with the labile thiazolidones,

$$\overset{1}{S} - \overset{2}{C}(NH) : \overset{3}{N}(C_6H_4OC_6H_5) - \overset{4}{C}O - \overset{5}{C}H_2,$$

which were made by the action of potassium thiocyanate on the omega-chloracet derivatives in absolute alcohol. The ortho-phenoxyaniline derivatives proved to be much more stable than the corresponding para derivatives. The para readily rearranged to the stable type by heating in dilute alcohol or by allowing it to stand for several days in ninety-five percent alcohol. The ortho rearranged best by use of acetic acid. The unstable type became relatively stable as soon as the imino group was substituted. The imino group reacted with RNCO and RCOCl compounds very readily, forming urea and acylimino derivatives, respectively. Also under certain conditions substitution at position No. 5 could be made without rearrangement. Substitution at position No. 5 stabilized the ring so that it was not broken by acid hydrolysis. All methods of hydrolysis for the unsubstituted, labile types failed to yield evidence as to structure, except in the case of acid hydrolysis, which yielded substituted hydantoic acids. Substitution at position No. 5 raised the melting point of the compounds, whereas substitution at position No. 3 lowered the melting point. These unstable compounds gave non-isolated sodium salts as shown by their reactions. A stable HCl salt could be formed by using hydrogen chloride gas, which could be neutralized to give the original unstable form.

EXPERIMENTAL

PREPARATION OF INTERMEDIATES

p-Phenoxynitrobenzene, $C_6H_5OC_6H_4NO_2$ (I)

This was made by the Ullman method by heating a mixture of potassium phenolate, copper powder and *p*-chloronitro benzene. On reduction with zinc dust and calcium chloride (2) it gave *p*-phenoxyaniline (II) which boiled at 187-189° at 14 m.m. and melted at 83.5° C. Some derivatives of this were made for identification purposes.

α-*p*-Phenoxyphenyl-β-Phenylurea,

$$C_6H_5OC_6H_4NHCONHC_6H_5 \quad (III)$$

This was made by the condensation of phenyl isocyanate and the phenoxyaniline in dry benzene solution. The white crystals from alcohol melted at 194°.

Anal. Calcd. for $C_{19}H_{16}N_2O_2$: N, 9.21. Found: 9.12, 9.23.

p-Phenoxyphenyl-ethylamine, $C_6H_5OC_6H_4NHC_2H_5$ (IV)

This was the product formed by refluxing *p*-phenoxyaniline with ethyl iodide. The yellow oil boiled at 213-214° at 32 m.m.

α-*p*-Phenoxyphenyl-α-ethyl-β-Phenylurea,

$$C_6H_5OC_6H_4\overset{\displaystyle C_2H_5 \atop |}{N}-CONHC_6H_5 \quad (V)$$

When the secondary amine (IV) was treated with phenylisocyanate, a little of the urea melting at 194° (III) was obtained, showing the presence of traces of the phenoxyaniline. However, the main product was the more soluble urea (V), which melted at 118°.

Anal. Calcd. for $C_{21}H_{21}N_2O_2$: N, 8.43. Found: 8.24, 8.43.

p-Phenoxyphenylisothiocyanate, $C_6H_5OC_6H_4N\,C\,S$ (VI)

Efforts to prepare this by heating the di-*p*-phenoxyphenylthiourea (m.p. 163-164°) with sulfuric acid or acetic anhydride were fruitless. A very poor yield resulted from the interaction of thiophosgene with the phenoxyaniline, but fairly good results (60%) were obtained by the action of lead nitrate on the ammonium di-thio-*p*-phenoxyphenyl carbamate (3). The mustard oil was extracted from the lead sulfide with hot alcohol. It had a characteristic odor and melted at 42°.

Anal. Calcd. for $C_{13}H_9ONS$: N, 6.15. Found: 6.22, 6.32.

α-*p*-Phenoxyphenyl-β-ethyl thiourea,

$$C_6H_5OC_6H_4NHCSNHC_2H_5 \quad (VII)$$

This was easily prepared by adding an excess of ethylamine to an alcoholic solution of the above mustard oil. The compact crystals melted at 102°.

Anal. Calcd. for $C_{15}H_{16}N_2OS$: N, 10.30. Found: 10.10, 10.24.

α-p-Phenoxyphenyl-*β*-benzyl thiourea,

$$C_6H_5OC_6H_4NHCSNHCH_2C_6H_5 \quad \text{(VIII)}$$

The thiourea formed by the interaction of the isothiocyanate and benzylamine in ether-benzene solution melted at 150° when recrystalized from benzene.

Anal. Calcd. for $C_{20}H_{17}N_2OS$: N, 8.40. Found: 8.23, 8.21.

α-p-Phenoxyphenyl-*α*-benzyl-*β*-phenyl urea,

$$C_6H_5OC_6H_4C_7H_7NCONHC_6H_5 \quad \text{(IX)}$$

When paraphenoxyaniline was refluxed in alcohol solution with benzyl chloride, phenoxyphenylbenzylamine was obtained as an oil boiling at 293-305° at 40 m.m. This was dissolved in dry benzene and treated with phenyl isocyanate. The resulting urea melted at 185°.

Anal. calcd. for $C_{26}H_{22}N_2O_2$; N, 7.10. Found: 6.82.

THIAZOLIDONE SYNTHESIS (STABLE)

p-Phenoxychloroacetanilide, $C_6H_5OC_6H_4NHCOCH_2Cl$ (X)

The paraphenoxyaniline (1 mol.) was dissolved in a mixture of acetone and pyridine (2 mols.). To this was slowly added chloroacetylchloride (1⅕ mols.). After standing for one hour the crude product was purified by crystallization from alcohol. The fine white needles melted at 101°.

Anal. Calcd. for $C_{14}H_{12}NO_2Cl$: N, 5.36. Found: 5.30, 5.43.

2-*p*-Phenoxyphenylamino-4-thiazolidone,

$$\underbrace{\overset{1}{S}-\overset{2}{C}(NHC_6H_4OC_6H_5)\overset{3}{N}\overset{4}{C}O\overset{5}{C}H_2} \quad \text{(XI)}$$

This is the stable form, and was made by refluxing for four hours the chloroacet-derivative (X) and potassium thiocyanate in alcohol solution. On pouring into water the yellow thiazolidone separated, which melted at 183.5° after crystallization from alcohol. The same thiazolidone was also prepared by the action of ethylchloroacetate on monophenoxyphenylthiourea.

Anal. Calcd. for $C_{15}H_{12}N_2O_2S$: N, 9.86. Found: 9.75, 9.77.

The labile or 2-imino-3-paraphenoxyphenyl-4-thiazolidone will be discussed later.

Acid Hydrolysis. The thiazolidone (XI) was hydrolyzed by the action of hydrogen chloride in hot acetic acid into *p*-phenoxyaniline and 2, 4-thiazoldione (m.p. 125°).

Benzal Derivative. It condensed readily with benzaldehyde in alcohol solution with a few drops of sodium hydroxide, forming 2-*p*-phenoxyphenylamino-5-benzal-4-thiazolidone,

$$S - C(NHC_6H_4OC_6H_5)NCOC = CHC_6H_5$$

(XII) which melted at 241°.

Anal. Calcd. for $C_{22}H_{16}N_2O_2S$; N, 7.53. Found: 7.73, 7.75.

Sodium Salt. This was obtained by dissolving the thiazolidone (XI) in hot twenty-percent sodium hydroxide. On cooling, the sodium salt separated, and could be purified by crystallizing from a mixture of benzene and alcohol.

Ethyl Derivatives. The dry sodium salt was dissolved in ethyl alcohol and an excess of ethyl iodide added. After refluxing eight hours it was steam distilled and the residue taken up in ether. The ether solution was extracted with acid and the extract neutralized with ammonium hydroxide. The compound which separated melted at 108° (yield 28 grs.) and was proven to be 2-*p*-phenoxyphenyl-2-ethylamino-4-thiazolidone,

$$S - C(NC_6H_4OC_6H_5,C_2H_5)\ NCOCH_2 \qquad (XIII)$$

Anal. Calcd. for $C_{17}H_{17}N_2O_2S$: N, 8.95. Found: 8.94, 8.91.

From the residual ether solution was isolated one gram of the 3-ethyl derivative (XIV), melting at 124°.

Proof of Constitution of XIII. Since acid hydrolysis failed to give satisfactory results, it was refluxed for four hours in an alcoholic sodium hydroxide solution. Water precipitated a product which crystallized from ether in large clear needles, melting at 72°. This was shown to be paraphenoxyphenylethylcyanamide,

$$C_6H_5OC_6H_4C_2H_5NCN \quad (XV),$$

the formation being due to the opening of the ring and loss of thioacetic acid. This proved the position of the ethyl group at position No. 2.

Anal. Calcd. for $C_{15}H_{14}ON_2$; N, 11.76. Found: 11.58, 11.65.

For further proof the cyanamide (XV) was synthesized as follows: Some *p*-phenoxyphenylethylamine was made by refluxing *p*-phenoxyaniline with ethyl iodide and vacuum distilling the oil, which boiled at 213-214° at 32 m. m. pressure. This oil was treated

with cyanogen bromide and the resulting product taken up in ether. The ether solution was washed first with acid, then with alkali, to remove unchanged amines and the mono substituted cyanamide. The ether on evaporation yielded a compound which crystallized from heptane and melted at 72°. This was shown by mixed melting point and analysis to be identical with XV.

An independent proof of the constitution of the 2-*p*-phenoxyphenyl-2-ethylamino-4-thiazolidone was carried out as follows:

2-*p*-Phenoxyphenyl-2-ethylamino-5-benzal-4-thiazolidone,

$$S-C(NC_6H_4OC_6H_5\,C_2H_5)\,NCOC=CHC_6H_5 \quad \text{(XVI)}$$

This resulted from the condensation of the thiazolidone with benzaldehyde in alkaline-alcoholic solution. The pure compound melted at 176°.

Anal. Calcd. for $C_{24}H_{20}N_2OS$: N, 7.00. Found: 7.07, 7.17.

Contrary to our usual experience, this was readily hydrolyzed on boiling for thirty minutes in a strong alcohol-sodium hydroxide solution. From the solution was isolated 5-benzal-2, 4-thiazoldione (m.p. 240°) and an oil which with phenylisocyanate gave an urea (m. p. 118°) which, by mixed melting point and analysis, proved to be α-*p*-phenoxyphenyl-α-ethyl-β-phenyl urea (V); thus again confirming the structure assigned.

2-*p*-Phenoxyphenylimino-3-ethyl-4-thiazolidone,

$$S-C(NC_6H_4OC_6H_5)N(C_2H_5)COCH_2 \quad \text{(XIV)}$$

As previously stated (page 5), this was obtained in three-percent yield on the ethylation of the sodium salt of the thiazolidone (XI).

Anal. Calcd. for $C_{17}H_{17}N_2O_2S$: N, 8.93. Found: 8.88, 8.86.

It was synthesized for comparison by heating an alcoholic mixture of α-*p*-phenoxyphenyl-β-ethylthiourea (VII), ethylchloroacetate and pyridine. This product melted at 124° and was shown to be identical with (XIV), thus proving the position of the aryl and alkyl groups.

BENZYL DERIVATIVES

2-*p*-Phenoxyphenyl-2-benzylamino-4-thiazolidone,

$$S-C(NC_6H_4OC_6H_5CH_2C_6H_5)NCOCH_2 \quad \text{(XVII)}$$

The sodium salt of the thiazolidone (XI) was boiled in alcohol solution with benzyl chloride. The residue left after steam distillation was insoluble in dilute acid. After crystallization from benzene it melted at 125-126°.

Anal. Calcd. for $C_{22}H_{18}N_2O_2S$: N, 7.49. Found: 7.60, 7.57.

That it had this constitution was proven by the fact that it differed from its isomer 2-*p*-phenoxyphenylimino-3-benzyl-4-thiazolidone (XVIII) which melted at 108°. This was synthesized by the action of chloroacetylchloride on *α*-*p*-phenoxyphenyl-*β*-benzylthiourea (VIII) in acetone-pyridine solution.

Anal. Calcd. for $C_{22}H_{18}N_2O_2S$: N, 7.49. Found: 7.37.

It condensed in the usual manner with piperonal yielding the 3-4 methylene-dioxybenzal derivative which melted at 133°, XIX.

Anal. Calcd. for $C_{30}H_{22}N_2O_4S$: N, 5.53. Found: 5.49, 5.40.

ACTION OF BENZOYL CHLORIDE

2-*p*-Phenoxyphenyl-2-benzoylamino-4-thiazolidone,

$S — C(NC_6H_4OC_6H_5\ COC_6H_5)\ N — COCH_2$ (XXII)

This, the first illustration of this type of benzoyl derivative, was synthesized when the sodium salt of XI was treated, in water or alcohol solution, with the calculated amount of benzoyl chloride. An orange-colored product was obtained, which melted at 165°, when crystallized from an alcohol-benzene solution.

Anal. Calcd. for $C_{22}H_{16}N_2O_3S$: N, 7.22. Found, 7.28, 7.33.

The compound was hydrolyzed with ten percent HCl in an autoclave at thirty-five pounds pressure for two and one half hours, and from the reaction mixture was isolated 2, 4-thiazoldione (m.p. 128°), paraphenoxyaniline and benzoic acid.

That the benzoyl group is at position No. 2 is indicated by its analogy to the action of acetic anhydride on 2-phenylimino-4-thiazolidone, which gave 2-phenyl-2-acetylamino-4-thiazolidone; the constitution of the latter was proven by its synthesis from *α*-phenyl-*α*-acetylthiourea and chloroacetylchloride (4).

DERIVATIVES OF THE *α*-*β*-DISUBSTITUTED THIOUREA

2-*p*-Phenoxyphenylimino-3-*p*-Phenoxyphenyl-4-thiazolidone,

$S — C(NC_6H_4OC_6H_5)\ N\ (C_6H_4OC_6H_5)\ COCH_2$ (XX)

This was made by boiling the diphenoxyphenylthiourea and ethylchloroacetate either in alcohol-pyridine solution or in glacial acetic acid. The crystals from benzene melted at 131°.

Anal. Calcd. for $C_{27}H_{20}N_2O_3S$: N, 6.19. Found: 6.44, 6.28.

Its 5-benzal derivative (XXI) formed fine yellow crystals from benzene and melted at 151°.

Anal. Calcd. for $C_{34}H_{24}N_2O_3S$: N,-5.61. Found: 5.40.

THIAZOLIDONE SYNTHESIS (*Labile Para*)

2-Imino-3-*p*-Phenoxyphenyl-4-thiazolidone,

$S-C(NH)N(C_6H_4OC_6H_5)COCH_2$ (XXIII)

It has been mentioned previously that long boiling of the alcohol solution of potassium thiocyanate and *w*-chloro-*p*-phenoxyacetanilide (X) gave only the stable thiazolidone XI (m.p. 184°). By modifying the conditions, the intermediate products were readily isolated.

The chloroacet compound (7 gms.) and potassium thiocyanate (3 gms.) were refluxed for fifteen minutes in absolute alcohol. On cooling the filtered solution, white crystals of the thiocyan-*p*-phenoxyacetanilide, $C_6H_5OC_6H_4NHCOCH_2SCN$, (XXIV) separated which melted at 106-107°.

Anal. Calcd. for $C_{15}H_{12}N_2O_2S$: N, 9.86. Found: 9.59, 9.53.

This thiocyanate could be recrystallized without change from ninety-five percent alcohol, provided the concentration was such that it separated out quickly. If it was of such concentration that all stayed in solution on cooling, a rearrangement took place which caused after fifteen hours a crystallization of long, fine, white insoluble needles. These were moderately soluble in hot alcohol and melted at 132-133°. This proved to be the unstable thiazolidone (XXIII).

Anal. Calcd. for $C_{15}H_{12}N_2O_2S$: N, 9.86. Found, 9.69, 9.74.

On long standing or boiling in alcohol solution this labile form changed to the stable form (XI). However, it was found that repeated crystallization of the labile form from the same alcohol solution produced a crystalline mixture melting at 122-123°. Investigation revealed these crystals to be a mixture of the stable and labile forms. They were separated by the greater insolubility of the stable form in hot benzene.

REACTIONS OF THE "LABILE" THIAZOLIDONE

2-Imino-3-*p*-Phenoxyphenyl-5-benzal-4-thiazolidone,

$S-C(NH)N(C_6H_4OC_6H_5)COC=CHC_6H_5$ (XXV)

Under the influence of piperidine or sodium hydroxide in absolute alcohol solution, the labile thiazolidone (XXII) condensed with benzaldehyde, yielding the above benzal compound which melted at 174°. The same product was obtained in an interesting way from the thiocyanate (XXIV) and benzaldehyde in absolute alcohol solu-

tion with piperidine. Here evidently the thiocyanate rearranged to the labile form and then condensed to form the benzal derivative (XXV). The melting point of this compound was lowered by repeated crystallization from alcohol, due to partial rearrangement to the benzal derivative of the stable form (XII), thus giving a mixture of the benzal derivatives of the stable and unstable thiazolidones.

UREA FORMATION

α-(α-Napthyl)-β, 2-(3-paraphenoxyphenyl-4-thiazolidone) urea,

$S - C(NCONHC_{10}H_7)\ N\ (C_6H_4OC_6H_5)\ COCH_2$ (XXVI)

When the labile thiazolidone (XXIII) and α-naphthyl isocyanate were dissolved in dry benzene, the urea slowly separated. Crystallized from acetone alcohol, it melted at 247°.

Anal. Calcd. for $C_{20}H_{19}N_3O_3S$: N, 9.28. Found, 9.53.

α-Naphthylisocyanate would not react with the corresponding stable form (XI).

α-(α-Naphthyl-β, 2-(3-p-Phenoxyphenyl-5-benzal-4-thiazolidone) urea, $S - C(NCONHC_{10}H_7)\ N\ (C_6H_4OC_6H_5)\ COC = CHC_6H_5$ (XXVII)

This was made by refluxing the thiazolidone (XXVI) with benzaldehyde in the usual manner. The light yellow needles melted at 221°.

Anal. Calcd. for $C_{33}H_{23}N_3O_3S$: N, 7.77. Found: 7.93.

The same compound was obtained by the action of α-naphthyl isocyanate on the unstable benzal derivative (XXV), thus confirming the structure.

BENZOYL DERIVATIVES

2-Benzoylimino-3-p-Phenoxyphenyl-4-thiazolidone,

$S - C(NCOC_6H_5)\ N\ (C_6H_4OC_6H_5)\ COCH_2$ (XXVIII)

A mixture of the labile thiazolidone (XXIII), benzoyl chloride and dilute sodium hydroxide was heated. The resulting product crystallized from alcohol in white needles, melting at 214°.

Anal. Calcd. for $C_{22}H_{16}N_2O_3S$: N, 7.22. Found: 6.92, 7.08.

The isomeric benzoyl derivative from the stable thiazolidone had a melting point of 165° (XXII). The constitution of this unusual compound, the only thiazolidone thus far obtained with an acyl group at position No. 2 and an aryl group at position No. 3, was proved as follows: α-benzoyl-β-p-phenoxyphenyl-thiourea,

$C_6H_5CONHCSNHC_6H_4OC_6H_5$ (XXIX)

was readily prepared by the action of benzoylisothiocyanate on

p-phenoxyaniline (5). When crystallized from acetone it melted at 128°.

Anal. Calcd. for $C_{20}H_{15}N_2O_2S$: N, 8.05. Found: 8.09.

The thiourea was dissolved in acetone, and pyridine and chloroacetyl chloride added. After standing twenty hours the solution was allowed to evaporate. A small yield of a compound melting at 214° was obtained from the residue. By mixed melting point this was proven to be the benzoyl thiazolidone (XXVIII).

DERIVATIVES OF *o*-PHENOXYANILINE

o-Phenoxyphenylthiourea. (XXX).

This was made by evaporating a solution of the amine hydrochloride with ammonium thiocyanate and melted at 124° (6).

2-*o*-Phenoxyphenylamino-4-thiazolidone (XXXI).

A satisfactory procedure for its preparation was to reflux, for three hours, an alcoholic solution of the thiourea (XXX) with ethylchloroacetate and pyridine. The "stable" product was light yellow and melted at 147.5°. No unstable form was obtained.

Anal. Calcd. $C_{15}H_{12}N_2O_2S$: N, 9.86. Found: 9.87, 9.95.

2-*o*-Phenoxyphenylamino-5-benzal-4-thiazolidone (XXXII).

This thiazolidone was obtained from XXXI in the usual manner without refluxing. The light-yellow crystals melted at 213°.

Anal. Calcd. for $C_{22}H_{15}N_2O_2S$: N, 7.53. Found: 7.73, 7.93.

Heating in an autoclave at fifteen pounds for fifteen minutes with 3.5 percent HCl gave almost quantitative yields of *o*-phenoxyaniline and 5-benzal-2, 4-thiazoldione, thus proving the structure of XXXI.

The yellow *p*-dimethylamino-benzal derivative of XXXI was made in the same manner as the other benzal derivatives and melted at 230° (XXXIII).

Anal. Calcd. for $C_{24}H_{21}N_3O_2S$: N, 9.88. Found: 9.97, 10.04.

The above compound XXXIII was hydrolyzed on boiling with eighteen percent HCl, yielding *o*-phenoxyaniline and the orange-yellow colored 5-*p*-dimethylaminobenzal-2, 4-thiazoldione,

$$S - CONHCOC = CHC_6H_4N(CH_3)_2 \quad \text{(XXIV)}$$

which melted at 292°.

Anal. Calcd. for $C_{12}H_{12}N_2O_2S$: N, 11.29. Found: 11.45.

The sodium salt of XXXI.

This could be made by dissolving the thiazolidone in sodium hydroxide or by a rather unusual method, viz., refluxing a benzene

solution of the thiazolidone with metallic sodium; the insoluble sodium salt was washed with benzene and recrystallized from alcohol. It then melted at 64°, resolidified and again fused at 236°—a result that would indicate alcohol of crystallization.

Analysis of product melting at 236° (XXV).

Anal. Calcd. for $C_{15}H_{11}N_2O_2S\,Na$: N, 9.15. Found: 9.14, 9.21.

Analysis of product melting at 64° (XXXVI).

Anal. Calcd. for $C_{15}H_{11}N_2O_2SNa \cdot 2C_2H_5OH$: N, 7.03. Found: 7.08, 6.88.

2-*o*-Phenoxyphenyl-2-ethylamino-4-thiazolidone, XXXVII.

The above sodium salt, when dissolved in alcohol and refluxed with ethyl iodide, yielded only one ethyl derivative, in which the ethyl group was at position No. 2. The compound melted at 112°.

Anal. Calcd. for $C_{17}H_{16}O_2N_2S$: N, 8.95. Found: 8.85, 8.90.

The 5-dimethylamino-benzal derivative (XXXVIII) was isolated as orange-colored crystals from benzene, melting at 210°.

Anal. Calcd. for $C_{26}H_{23}N_3O_2S$: N, 9.48. Found: 9.42.

THE ISOMERIC "LABILE" FORMS (ORTHO)

The so-called "labile" forms of the orthophenoxyphenyl derivatives were characterized by unusual stability and showed in general the reactions of the isomeric para derivatives (XXIII).

Omega-chloro-*o*-phenoxyacetanilide,

$C_6H_5OC_6H_4NHCOCH_2Cl$ (XXIX)

A solution of *o*-phenoxyaniline in dry acetone was treated with chloroacetylchloride and pyridine. The product, from alcohol, melted at 79°.

Anal. Calcd. $C_{14}H_{12}NO_2Cl$: N, 5.35. Found: 5.22, 5.37.

Heating this compound with potassium thiocyanate in alcohol solution for periods varying from twenty minutes to three hours gave only the labile form of the thiazolidone, 2-imino-3-*o*-phenoxyphenyl-4-thiazolidone, XL, and not the expected thiocyanate as in the case of the para compound (XXIV). This labile form crystallized from alcohol or heptane as clear whitish needles and melted at 97.5°.

Anal. Calcd. for $C_{15}H_{12}N_2O_2S$: N, 9.86. Found: 9.79, 9.82.

Properties of XL. The dry thiazolidone can be heated to 130° for twenty minutes without change, and heating for less than eight hours produced no change. Longer than eight hours gave unidentifiable products. Dry HCl gas gave a salt which melted at 242°,

which could be neutralized to give the original compound. The HCl salt, when heated in glacial acetic acid with sodium acetate and benzaldehyde, gave the benzal derivative of the stable form, melting at 213° (XXII). The benzal derivative of the labile form could not be obtained.

Hydrolysis of XL. Heating with dilute acid usually gave *o*-phenoxyaniline, thioglycollic acid and gummy products. However, more or less complete conversion to the stable form XXXI resulted in the following cases. (A) Heating at fifteen pounds pressure for twenty minutes with HCl (2 c.c.) and water (80 c.c.). (B) Dissolving in glacial acetic acid and heating for twenty minutes at fifteen pounds pressure caused almost quantitative rearrangement to the stable form (m. p. 147.5°). (C) Cooling rapidly a hot aqueous solution of the acid salt of the unstable form. (D) Some rearrangement is produced by refluxing a short time with alcoholic potassium hydroxide.

Thiohydantoic Acid: Hydrolysis to a thiohydantoic acid was accomplished by dissolving in 60 c. c. of alcohol and 10 c. c. of HCl. After refluxing for two hours, the solution was evaporated and from the residue was obtained a white hydrochloride salt, melting at 129°. It gave tests for sulfur, nitrogen and chlorine and decomposed with alkali to phenoxyaniline and unidentified products.

Anal. Calcd. for $C_{15}H_{14}N_2O_3S \cdot HCl$. N, 8.27; HCl, 10.76. Found: N, 8.29; HCl, 11.00.

These results agree with the assumption that the compound (m. p. 129°) is the hydrogen chloride salt of *o*-phenoxyphenylthiohydantoic acid, $C_6H_4OC_6H_5NHC(NH)SCH_2COOH \cdot HCl$ (XLI).

This is in harmony with the observation of Wheeler and Johnson (7), who obtained from the labile 2-imino-3-phenyl-4-thiazolidone, a phenyl hydantoic acid.

UREA DERIVATIVES

α-(*α*-Naphthyl)-*β*, 2-(3-*o*-Phenoxyphenyl-4-thiazolidone) Urea,

$$\underset{|}{S}-C(NCONHC_{10}H_7)\,N\,(C_6H_4OC_6H_5)\,CO\underset{|}{C}H_2 \quad (XLII)$$

The above compound resulted from the reaction of the 2-imino compound (XL) with *α*-naphthylisocyanate in benzene on standing for several days. The white crystals from an acetone-alcohol solution melted at 129°.

Anal. Calcd. for $C_{26}H_{19}N_3O_3S$: N, 9.28. Found: 9.01.

When this compound was heated in alcohol (60 c.c.) and hydrochloric acid (10 c.c.), there was isolated some gummy products,

di-α-naphthylurea and a compound containing sulphur, chlorine and nitrogen; the analysis of which agreed with its formulation as the hydrochloride salt of the α-naphthyl urea of *o*-phenoxyphenylthiohydantoic acid,

$C_{10}H_7NHCONC(NHC_6H_4OC_6H_5)SCH_2COOH \cdot HCl$ (XLIII)

This pure white compound melted at 172°.

Anal. Calcd. for $C_{26}H_{22}N_3O_4SCl$: N, 8.28. Found: 8.41.

The naphthylurea (XLII) was found to condense with *p*-dimethylamino-benzaldehyde, yielding α(α-naphthyl)-β, 2(3-*o*-phenoxyphenyl-5-*p*-dimethylaminobenzal-4-thiazolidone) urea, XLIV; a very difficultly soluble yellow product melting at 209°.

Anal. Calcd. for $C_{35}H_{28}N_4O_3S$: N, 9.94. Found: 9.59.

This compound on acid hydrolysis gave di-α-naphthylurea and 3-*o*-phenoxyphenyl-5-*p*-dimethylaminobenzal-2, 4-thiazoldione, XLV, melting at 167°, which will be described later. (Page 226.)

The naphthyl urea (XLII) likewise condensed with benzaldehyde in the usual manner, yielding light-yellow crystals, melting at 227° (LIII).

Anal. Calcd. for $C_{33}H_{23}N_3O_3S$: N, 7.76. Found: 7.70.

This product was very stable, but on heating with eighteen per-cent HCl at forty pounds for two hours hydrolysis occurred. The compounds isolated were di-α-naphthylurea and 3-*o*-phenoxyphenyl-5-benzal-2, 4-thiazoldione, XLVI, which separated from benzene in yellow crystals, melting at 178°.

Anal. Calcd. for $C_{22}H_{15}NO_3S$: N, 3.73. Found: 3.98.

DERIVATIVES OF PHENYLISOCYANATE

α-Phenyl-β, 2(3-*o*-Phenoxyphenyl-4-thiazolidone) urea.

$S - C(NCONHC_6H_5)N(C_6H_4OC_6H_5)COCH_2$ (XLVII)

The labile thiazolidone (XL) and phenylisocyanate gave, in benzene solution, the above urea. The white crystals melted at 190°.

Anal. Calcd. for $C_{22}H_{27}N_3O_3S$: N, 10.42. Found: 10.44.

The yellow 5-benzal derivative of XLVII melted at 242°, XLVIII.

Anal. Calcd. for $C_{29}H_{21}N_3O_3S$: N, 8.55. Found: 8.37.

When the phenylurea (XLVII) was treated with alcohol (60 c.c.) and HCl (10 c.c.) and refluxed a short time, a compound was obtained which corresponded to a salt of a thiohydantoic acid. This white compound melted at 139°, and had the probable formula,

$C_6H_5OC_6H_4NHC(NHCONHC_6H_5)SCH_2COOH \cdot HCl$ (XLIX)

Anal. Calcd. for $C_{22}H_{20}N_3O_4SCl$: N, 9.81. Found: 9.90.

2-Benzoylimino-3-*o*-Phenoxyphenyl-4-thiazolidone,

$$S - C(NCOC_6H_5)\ N\ (C_6H_4OC_6H_5)\ COCH_2 \quad (L)$$

A mixture of the labile thiazolidone (XL), benzoyl chloride and sodium hydroxide solution gave an insoluble product which was purified from acetone. The yellowish crystals melted at 164° C.

Anal. Calcd. for $C_{22}H_{16}N_2O_3S$: N, 7.22. Found: 7.36, 7.44.

When *o*-phenoxyaniline was treated with benzoylisothiocyanate fine white crystals, melting at 172°, were formed, which proved to be *a*-*o*-phenoxyphenyl-*β*-benzoylthiourea,

$$C_6H_5OC_6H_4NHCSNHCOC_6H_5 \quad (LI)$$

Anal. Calcd. for $C_{20}H_{16}N_2O_2S$: N, 8.05. Found: 8.00.

This, however, failed to give the thiazolidone (L) with chloroacetylchloride, and hence proof of structure as in the case of the corresponding *p*-derivative was not realized.

Hydrolysis of the thiazolidone (L) with dilute acid gave the hydrochloride salt of *o*-phenoxyphenylthiohydantoic acid, which has been previously described (XLI).

When the thiazolidone L was treated with *p*-dimethylaminobenzaldehyde in the usual manner, condensation occurred with the formation of 2-benzoylimino-3-orthophenoxyphenyl-5-p-dimethylaminobenzal-4-thiazolidone, LII, which melted at 233° C.

The same product was obtained by condensing the labile thiazolidone (XL) and *p*-dimethylaminobenzaldehyde and causing this product to react with benzoyl chloride. The deep-orange crystals melted at 233° C. and were proven by mixed melting points and analysis to be identical.

Anal. Calcd. for $C_{31}H_{25}N_3O_3S$: N, 8.09. Found: 7.88, 7.91.

Hydrolysis in acid solution eliminated the benzoyl group and gave 3-*o*-phenoxyphenyl-5-*p*-dimethylaminobenzal-2, 4-thiazoldione, XLV, the yellow crystals melting at 167° C.

Anal. Calcd. for $C_{24}H_{20}O_3N_2S$: N, 6.73. Found: 6.80.

SUMMARY

Substitution of *o*- or *p*-phenoxyphenyl at position No. 2 showed the characteristic reactions of the analogous derivative previously studied.

The 2-imino derivatives, which are the so-called "labile" types, were found to be more stable in the ortho series than in the para

series. They both gave stable benzoyl and urea derivatives, which were studied in detail, as were the corresponding substitution derivatives at position No. 5.

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Notes on the Snakes of the Genus *Salvadora*

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ABSTRACT: A brief synopsis, with a key, is presented of the differential characters of the six species and subspecies of the genus *Salvadora*. The study is based on thirty-three specimens, twenty-three of which are from Mexico, representing all known forms of the genus.

THE following notes are based upon thirty-three specimens, mostly Mexican, of six species and subspecies of *Salvadora*. Most of the material is contained in the Mexican collection of Dr. E. H. Taylor and myself. Catalogue numbers, unless otherwise stated, refer to specimens in this collection. The remainder of the material studied is in the Dyche Museum of Natural History at Kansas University. These specimens are designated by KU.

Two rather distinct groups in the genus are apparent, one containing *mexicana* and *pulcherrima*, the other containing *bairdii*, *grahamiae*, *hexalepis* and *virgultea*. The separate identity of *bairdii* is beyond question, but its relationship to *grahamiae* is yet uncertain. Most recent authors have considered *grahamiae* and *hexalepis* subspecies of each other. With reluctance I have adhered to this conclusion, but the matter does not seem definitely proved.

I am indebted to Dr. E. H. Taylor for assistance in the preparation of this paper, and for making possible the collection of much of the Mexican material; and to Mr. C. D. Bunker for permission to study the material in the Dyche Natural History Museum.

KEY TO THE FORMS OF THE GENUS SALVADORA

1. One preocular; tail thirty percent of total length, or more; subcaudals 121 to 189; three supralabials entering eye; rostral not greatly enlarged.............. 2
   Two or more preoculars; tail less than thirty percent of total length; subcaudals 82 to 103; one or two supralabials entering eye; rostral sometimes greatly enlarged 3
2. Stripes extending the full length of body and tail.................. *pulcherrima*, p. 230
   Stripes broken on anterior part of body and replaced on neck by indistinct crossbands .... *mexicana*, p. 231

3. Anterior section of nasal separated from second supralabial; dorsolateral dark stripes terminating on nape, not passing over temporal region of head....*bairdi*, p. 232
Anterior section of nasal in contact with second supralabial; dorsolateral dark stripes may or may not pass across temporal region to eye.................... 4
4. Two loreals; second supralabial separated from loreals; nine or ten supralabials.. 5
One loreal; second supralabial in contact with loreal; eight, rarely nine, supralabials; dorsolateral dark stripes passing across temporal region to eye.
g. grahamiae, p. 234
5. Middorsal light stripe one and two half scale rows wide on fore part of body; a single, broad, dark band on either side of middorsal light stripe, not passing onto temporal region, but fusing generally with color of head; usually only the sixth supralabial entering eye.................................*g. virgultea*,* p. 236

Middorsal light stripe three scales wide on fore part of body (wider on neck); two dark bands lateral to middorsal light stripe, narrowly separated from each other; a distinct, dark, temporal stripe, continuous with upper dark band on body; usually two or more supraoculars enter eye..................*g. hexalepis*, p. 235

Salvadora pulcherrima (Cope)

(Plate XXII)

One specimen, a male (No. 4669), was collected near San Ricardo, Chiapas, September 2, 1936. It was found moving about the base of a red sandstone cliff.

The essential features of scutellation are: parietals truncate posteriorly; frontal emarginate on sides, wider anteriorly than posteriorly, slightly wedged between the parietals posteriorly, its length on a median line somewhat greater than that of the median suture of the parietals; prefrontals wider than long, extended onto loreal region; internasals as long as broad, rounded anteriorly, the median suture between them about two thirds the length of the median suture between prefrontals; maximum length of prefrontals slightly greater than that of internasals; rostral nearly one and one half times as long as broad, wedged posteriorly between internasals; anterior section of nasal subequal in size to posterior section, not in contact with second supralabial; dorsal border of naris formed by internasal; loreal single, narrow, elongate; one large preocular, extending dorsad and nearly completely separating prefrontal from supraocular; preocular in contact only with third supralabial; supraocular wider posteriorly than anteriorly, its greatest transverse diameter somewhat less than that of frontal; two postoculars, the lower somewhat smaller than upper; supralabials 8-8, the second and third in contact with loreal, the third, fourth and fifth entering eye (third very narrowly); temporals 2-2 on each side; infralabials 11-11, the first pair in contact on the median ventral line; two pairs of genials, the length of the first pair, on the median ventral line, slightly less than that of second pair; scales of second pair of genials

* Characters as proposed by Bogert (Bull. Southern Calif. Acad. Sci., vol. 34, part 1, 1935, pp. 88-94). with the exception of the absence of a temporal stripe.

separated by two small median scales anteriorly, by three scales posteriorly.

Dorsal scales smooth, with two apical pits, in 17-17-13 rows; gastrosteges 199; urosteges 138. The total length is 1,056 mm.; tail, 345 mm.; the latter is 32.7 percent of the total length.

The color pattern is quite distinctive. Most of the head scales are edged with black; general ground color of head light olive; ground color of body light olive anteriorly, fading to cream posteriorly; four distinct, black stripes on neck; the two medial stripes begin three scales back of the parietals; they are two scales wide on the nape and are separated medially by a light stripe five scales wide; a very short distance posteriorly they are separated by a width of three scales, diminishing to a width of one scale one fourth the distance from the snout; on the tail the median light stripe becomes narrower, very light brown, and occupies parts of two adjacent scale rows; the black stripes on either side of the middorsal light stripe become dark brown near the middle of the body and progressively lighter posteriorly; near the middle of the body, the scales near the edges of the dorsolateral dark stripes are dark-edged, while posteriorly only the upper edges of the scales on the lateral border of the dark stripes are black.

The lateral black stripes extend from the posterior border of the eye through the temporal region to the neck, where they are broken by a light area about the length of four scales; they continue posteriorly from the neck, where they are about two half scale rows wide, to the tail, becoming brownish on the posterior fourth of the body; over most of the length of the body the lateral stripes are one and one half scale rows wide, including the upper half of the lateral scale rows.

The belly and the ventral half of the first dorsal scale row are immaculate white; the chin and all except the upper edges of the supralabials are white.

Salvadora mexicana (Duméril and Bibron)

Thirteen specimens are available, from the following localities: *Colima:* Manzanillo (No. 4676). *Michoacán:* Hacienda El Sabino (Nos. 4680, 5265-8). *Guerrero:* Mexcala (Nos. 4673, 5269, 15424); 1 mi. N. of Organos, S. of El Treinte (No. 4674); El Treinte (No. 5270); Palo Blanco, S. of Chilpancingo (No. 4675).

This species agrees with *pulcherrima* in most respects, but has a somewhat larger rostral and the supralabials are nine on each side

instead of eight. The anterior section of the nasal is separated from the second supralabial in all specimens. The fourth, fifth and sixth supralabials border the orbit in all except one side of one specimen, in which the fourth is narrowly excluded by contact of the preocular and fifth supralabial. The dorsal scale formula is 17-17-13 in all. The infralabials are eleven except on one side of one specimen, and on both sides of another, in which there are ten.

Measurements (in mm.) and scale counts of *S. mexicana*

NUMBER.	Sex.	Ventrals.	Caudals.	Total length.	Tail.	Percent tail of total.
5266	♀	192	129	555	174	31.4
5269	♀	186	137	918	309	33.7
4676	♂	189	121	656	210	32.0
4673	♂	181	132	760	258	33.9
4675	♂	186	141	797	274	34.3
15424	♂	188	137	841	289	34.4
5267	♂	191	131	1,032	341	33.0
5268	♂	187	123	1,049	337	32.1
4674	♂	185	131	1,063	341	32.1
5265	♂	185	128	1,092	362	33.2
5271	♂	187	139	1,140	386	33.9
5270	♂	188	134	1,274	425	33.4
4680	♂	186	132	1,330	432	32.5

The species differs widely from others of the genus in coloration. The striped pattern is replaced on the anterior third or fourth of the body by a speckled pattern; on the neck the dark spots are arranged in irregular, indefinite cross-bars about six in number. Each dorsal head scute has a large, light area in the middle, surrounded by a darker area around the edge of the scale. A dark spot occurs at the lateral anterior edge of each caudal scute.

Salvadora bairdii (Jan)

Seven specimens are available, from the following localities: *Vera Cruz:* 1½ mi. W. of Acultzingo (Nos. 4668-9). *Puebla:* 12 mi. N. of Tehuacán (No. 5264). *Guanajuato*: San Felipe (No. 4670). *Jalisco*: Magdalena (Nos. 4670A, 4671). *Michoacán*: Uruapan (No. 4672).

The species is similar to *grahamiae grahamiae*, with which it has been synonymized by some authors, in most characters of cephalic

scutellation. There are eight supralabials; usually nine infralabials (10 on one side in two specimens); two preoculars; two postoculars; lower preocular wedged between third and fourth supralabials; second and third supralabials bordering loreal; latter single, deep; fourth and fifth supralabials enter eye. However, there are three definable differences in the cephalic scutellation of *grahamiae grahamiae* and *bairdii*. In the latter the anterior part of the nasal is not pushed back by the rostral, and is separated from the second supralabial by contact of the first supralabial and the posterior part of the nasal. In *g. grahamiae* the anterior section of the nasal is in contact with the second supralabial, presumably due to the enlargement of the rostral. In *g. hexalepis* the rostral is still further enlarged, resulting in a broader contact of the two scales mentioned.

Secondly, the rostral is not enlarged in *bairdii* as in *g. grahamiae*, and the lateral edges are but very slightly free. The outline of the anterior face of the rostral, in dorsal or ventral profile, is rounded in *bairdii*, nearly straight in *g. grahamiae*.

Thirdly, the second pair of genials in *bairdii* are separated throughout their length, as is usually the case in *g. hexalepis*; in *g. grahamiae* the scales usually are in contact throughout most of their length, being separated only posteriorly.

Further, the pre- and postoculars seem to vary less in *bairdii* than in *g. grahamiae*. There are invariably two pre- and two postoculars in the specimens examined of *bairdii*, while in six specimens of *g. grahamiae* the preoculars are 2-2, 2-2, 2-3, 2-3, 2-3, 3-4, and there are three postoculars on one side in one.

In ventral and caudal counts and in tail-total length proportions no differences are discernible.

The color pattern of *bairdii* is essentially similar to that of *g. grahamiae*, but there are two definite and constant differences. The dorsolateral dark stripes in *bairdii* are distinctly black-edged medially except on the posterior part of the body, not in *g. grahamiae*. In the latter the dorsolateral dark stripes pass distinctly onto the head, through the temporal region to the eye, while in *bairdii* the stripes terminate on the nape just posterior to the parietal and temporal regions.

Further, the narrow, lateral dark stripe in *bairdii* extends farther forward than in *g. grahamiae*. The median dorsal light stripe in the latter species is one and two half scale rows wide on the body near the anus, while in all but one specimen of *bairdii* the dorsal stripe has narrowed to the width of one scale row at this point.

In *bairdii* dark blue, irregular, vertical lines passing from the lateral dark line to the ventrals, frequently are visible on the neck. These are not or scarcely discernible in *g. grahamiae*.

Salvadora grahamiae grahamiae and *bairdii* are undoubtedly closely related—apparently more closely than *g. grahamiae* and *g. hexalepis*, as indicated by the greater number of definable differences between the latter two than between the former two. Upon the basis of present knowledge, however, it can merely be stated that *bairdii* and *g. grahamiae* are distinct from each other. The degree of difference between related forms is no criterion for determining whether the forms are species or subspecies. Two subspecies of a single species may have more obvious, more numerous and more easily defined differences (*e. g.*, *Sceloporus m. magister* and *m. rufidorsum*) than two closely related forms known to be distinct, specific entities through the existence of other evidence (*e. g.*, *Sceloporus m. magister* and *c. clarkii*). In the absence of evidence in the form of geographic trends of variation indicative of a blending of differential characters in an area between the known ranges of the two forms in question, I prefer to retain them as separate species.

Measurements (in mm.) and scale counts of *S. bairdii*

NUMBER.	Sex.	Ventrals.	Caudals.	Total length.	Tail.	Percent tail of total.
4672	♀	194	90	261	54	20 7
4668	♀	191	94	297	70	23.6
5264	♀	206	95	353	81	22 9
4670	♀	209	98	663	163	24 6
4670A	♀	197		688		
4669	♂	185	100	254	61	24 0
4671	♂	186	95	694	182	26 2

Salvadora grahamiae grahamiae Baird and Girard

Six specimens are in the collections, from the following localities: *Nuevo León:* Spring three miles west of Sabinas Hidalgo (No. 4677). *Texas:* Arroyo El Salado, 13 m. SE of Rio Grande City, Starr Co. (No. 4678); Lytle, Atascosa Co. (KU 11668). *New Mexico:* Carlsbad Caverns, Eddy Co. (KU 8380); Santa Rita, Grant Co. (KU 2142). *Arizona:* Montezuma Canyon, Huachuca Mts. (KU 5467).

Supralabials eight, except in one in which nine are present on one side; infralabials nine, except in one in which ten occur (both sides);

preoculars 2-2, 2-2, 2-3, 2-3, 2-3, 3-4; postoculars two, except on one side of one, where three occur; lower preocular inserted between third and fourth supralabials, except on one side of one (between fourth and fifth); second and third supralabials in contact with loreal; fourth and fifth supralabials usually entering eye (fifth and sixth on one side in one).

The anterior section of the nasal is in contact with the second supralabial in all. In two specimens, the second pair of genials are separated throughout their length.

Measurements (in mm.) and scale counts of *S. g. grahamiae*

NUMBER.	Sex.	Ventrals.	Caudals.	Total length.	Tail.	Percent tail of total.
11668. ..	♀	189	92	918	222	24 2
4677 .	♂	185	94	516	135	26.2
2142	♂		92	724	188	26.0
8380	♂	191	103	752	202	26.9
5467	♂	184	97	847	218	25.7
4678	♂	187	85	909	222	24 4

Salvadora grahamiae hexalepis (Cope)

Five specimens, from the following localities: *Sonora:* 50 kilom. S. of Nogales (No. 15426). *Arizona:* Roosevelt Dam, Gila Co. (KU 8429); Mohawk, Yuma Co. (KU 6997); Phoenix, Maricopa Co. (KU 8488); Tucson, Pima Co. (No. 4679).

Dorsal scales in 17-17-13 rows, as in *g. grahamiae* and *bairdii;* supralabials 9-9 in two, others 9-10, 10-10; infralabials 9-10, 10-10, 10-11, 11-11; preoculars two in all; postoculars 2-3 in one, 2-2 in others; anterior section of nasal in contact with second supralabial in all; loreals 2-2 in two specimens, 2-3 in one, 3-3 in two; third and fourth supralabials in contact with loreals, except on one side in two specimens, in which the third, fourth and fifth supralabials are in contact with the loreals; lower preocular wedged between the fourth and fifth supralabials except on one side in two specimens, in which it is wedged between the fifth and sixth. The supralabials entering the eye are as follows: 5-6-7, 7; 6,6; 6,6; 0,5. In the latter specimen, the sixth supralabial, which should enter the eye, is split transversely. A subocular, split usually from the upper edge of the fifth supralabial, is present on both sides in three, on one side in one (head crushed in other specimen). The second pair of genials are in contact in one specimen.

The subspecies differs from *g. grahamiae* in numerous characters: number of supralabials (nine or ten in *hexalepis*, eight or rarely nine in *grahamiae*); number of infralabials (nine to eleven, usually eleven, in *hexalepis;* nine or ten, usually nine, in *grahamiae*); number of loreals (two or three in *hexalepis*, one in *grahamiae*); second supralabial (in contact with loreal in *grahamiae*, not in *hexalepis*); rostral wider in *hexalepis;* anterior section of nasal more broadly in contact with second supralabial; second pair of chinshields more frequently separated in *hexalepis;* and ventral scales more numerous in *hexalepis*.

Measurements (in mm.) and scale counts of *S. g. hexalepis*

NUMBER.	Sex.	Ventrals.	Caudals.	Total length.	Tail.	Percent tail of total.
8488	♀	201	82	709	154	21.7
6997	♀	207	95	826	182	22 0
4679	♂	201	86	684	163	23 8

Salvadora grahamiae virgultea Bogert

One specimen examined, from Escondido, San Diego county, California (KU 8487). It is a young female, agreeing in most characters with Bogert's description (Bull. Southern Calif. Acad. Sci., Vol. 34, 1935, part 1, pp. 88-94). The dorsals are in 17-17-13 rows; ventrals 201; caudals 84; supralabials 9-9; infralabials 11-11; preoculars 2-2; postoculars 2-2; loreals 2-2; third and fourth supralabials touch loreals; lower preocular between fourth and fifth supralabials; fifth and sixth supralabials enter eye on one side, sixth on other; subocular present on one side; total length 277 mm.; tail 59 mm.; ratio, tail to total length, .213.

In addition to the characters pointed out by Bogert, it appears that *g. virgultea* differs from *g. hexalepis* also in lacking a distinct, dark temporal stripe. It agrees in this respect with *bairdii*.

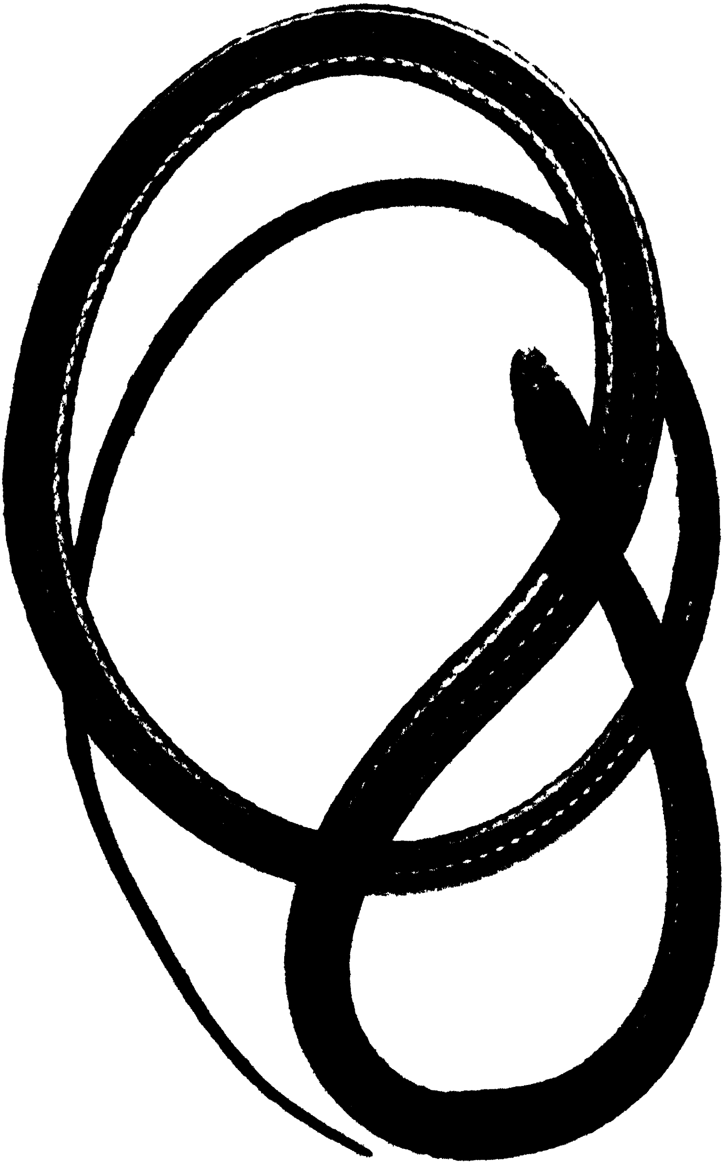

PLATE XXII

Salvadora pulcherrima. San Ricardo, Chiapas. Total length, 1056 mm.

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Miscellaneous Notes on Mexican Snakes

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ABSTRACT: The following species of Mexican snakes are discussed: *Loxocemus bicolor* Cope; *Diadophis regalis dougesii* (Villada); *Conopsis frontalis* (Cope); *Xenodon angustirostris* Peters; *Geophis semidoliatus* Duméril and Bibron; *Geophis blanchardi* sp. nov. (related to *dubius* and *chalybaeus*); *Enulius unicolor* (Fischer); *Enulius sumichrasti* Bocourt; *Storeria dekayi* (Holbrook); *Storeria storerioides* (Cope); *Ninia diademata* Baird and Girard; *Chersodromus liebmanni* Reinhardt; *Conophis concolor* Cope; *Conophis vittatus* Peters; *Tantilla rubra* Cope; *Tantilla bocourti* (Günther); *Tantilla calamarina* Cope; *Stenorhina degenhardti apiata* Cope; *Stenorhina degenhardti quinquelineata* (Hallowell), *Clelia clelia* (Daudin).

THE following notes are based on specimens collected, for the most part, by the authors, in Mexico.

Loxocemus bicolor Cope

Loxocemus bicolor Cope, Proc. Acad. Nat. Sci. Philadelphia, 1861, p. 76 (type description; type locality, La Union, Salvador).

A single specimen of this species (EHT-HMS No. 4574, 2 mi. north Xaltianguis, Guerrero, Mexico) was collected on the highway at night during a downpour of rain; lights from my car disclosed it crawling across the road.

Rostral large, upturned, part visible above three fourths of the distance from frontal; internasals about half area of prefrontals, narrowed medially; prefrontals bordered by three labials; no loreal, frontal longer than its distance from end of the snout; parietals small, separated posteriorly by an occipital shield; one large preocular broadly in contact with the frontal; a supraocular, small, displaced backwards by the upper extension of the preocular; three postoculars; temporals 3+6+6+7; upper labials 11,11, the seventh and

eighth on the left side, the sixth, seventh and eighth on the right side are very small, as if the normal scales had segmented since the temporals above them are enlarged; fourth and fifth labial enter orbit; 13, 14, lower labials, three touching the anterior chinshields, which are more than double the size of the second pair; a large scale borders lower labials 4 to 7, inclusive, on left side, broken in two parts on right side; 13 scales between chinshields and first widened ventral; ventrals, 256; subcaudals 44; two pairs of divided preanals; scale formula 44, 36, 34, 34, 28, 26. Dark lavender brown, the head darker; the color likewise darker on the underside of head; ventral surface with considerable brownish pigment, the back part of each ventral light. An anal cream spot; a cream-colored area on snout below nostril.

Diadophis regalis dougesii (Villada)

Diadophis punctatus Dougesii Villada, La Naturaleza, III, 1874-76 (1876), pp. 226-230, pl (lower figure in color, and A-C). Type description; type locality "potreros de Balbuena" (east of Mexico City).

A single specimen in the collection (EHT-HMS No. 4587 ♀; near Corones, Guanajuato, Aug. 12, 1932. Taylor and Smith). It was taken crawling across the road early in the afternoon.

Ventrals, 203; anal divided; caudals, 49; upper labials, 7-7; lower labials, 8-8; preoculars, 2-2; postoculars, 2-2; temporals, 1+1+1, 1+2+2; labials touch chinshields, 5-5; labials enter eye, 3, 4; scale formula, 21, 17, 17, 15, 15. Measurements (in mm.): Total length, 504; tail, 87; body width, 11; head width, 10; head length, 14.6; parietal length, 6; parietal to tip of snout, 5.6; frontal

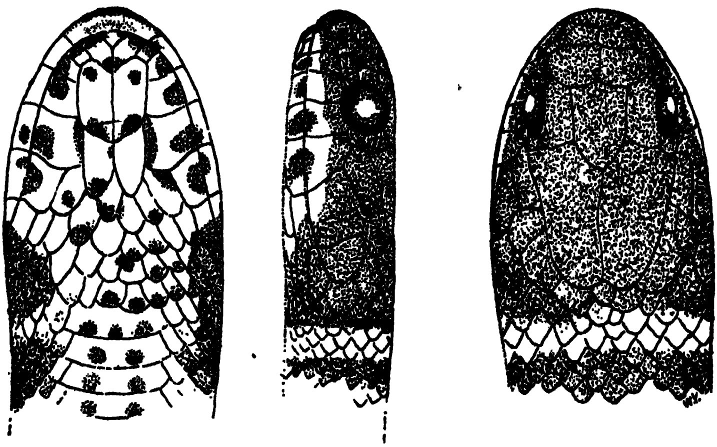

FIG. I. *Diadophis regalis dougesii* (Villada) EHT-HMS No. 4587; Corones, Guanajuato, Mexico. ×3.

length, 3.8; frontal width, 2.5; diameter of eye, 2.05; eye to nostril, 2.5. Maxillary teeth, 9-10, followed after an interspace by a large solid tooth. Scale preceding anal plate divided.

This form is a much heavier snake than the Arizona form, the head and body are distinctly wider, the head proportionally shorter.

The color is slaty gray to brownish gray, darker posteriorly, each scale with numerous silver flecks when seen under a lens. Head same, but darker; orange neck band about one and one half scale rows wide; outer edge of each ventral blackish, the color extending a third of the way across posterior part of ventrals. Outer row of scales without orange save the first four or five scales; labials with an orange line meeting on snout; many labials with spots or dark edges; chin and ventral surface orange with numerous small black spots, usually two on each ventral besides larger ones on outer edge of scale; under tail red-orange.

This specimen has nearly the same ventral count as that given for the type (202); the number of caudals is larger since the tail of the type specimen is incomplete. The type measured 650 mm. in length; the width of the body is 15 mm.

Conopsis frontalis (Cope).

(Plate XXIII, fig. 3)

Toluca frontalis Cope, Proc. Acad. Nat. Sci. Philadelphia, 1864, p. 167 (type description; type locality, Colima).

Ficimia olivacea (*part.*) Peters, Mon. Akad. Wiss. Berlin, 1869, p. 875.

Geagras frontalis Cope, Journ. Acad. Nat. Sci. Philadelphia, (2), VIII, 1876, p. 142 (States: "*Toluca frontalis* Cope, from Colima, is congeneric with this species [*Geagras redimitus*] in all technical characters."); Amer. Nat., 1884, p. 163; Bull. U. S. Nat. Mus., No. 32, 1887, p. 82 (Colima and Guadalajara).

Ficimia frontalis Garman, Mem. Mus. Comp. Zoöl. Harvard, VIII, No. 3, 1883, p. 82.

Pseudoficimia pulchra Bocourt, Mission Scientifique au Mexique et dans l'Amérique Centrale, Rept. Livr. 9, 1883, pp. 572-573, pl. XXXV, fig. 12, and 12a-12c (type description; type locality, "Mexique").

Pseudoficimia frontalis Günther, Biologia Centrali-Americana, Reptiles and Batrachia, May, 1893, p. 96 (Ventanas, Durango, and Presidio, Sinaloa); Cope, Ann. Rept. U. S. Nat. Mus., 1898 (1900), pp. 945-946.

Contia frontalis Boulenger, Cat. Snakes British Mus., 2d Ed. 1894, p. 270; Werner, Zoöl. Jahrb., 57, 1929, pp. 147, 149.

Conopsis frontalis Amaral, Mem. Inst. Butantan, IV, 1929, p. 182.

From the above synonymy it is obvious that opinions as to the generic relationship of this species have differed. The most reasonable association is with *Conopsis,* since its most closely related species is *Conopsis nasus.*

Two specimens of this form (EHT-HMS, 5203, 5204) were collected at Hacienda El Sabino, about 25 km. south of Uruapan, Michoacán, by Don Julio Raymond Bresson, who presented the specimens to Smith.

The following data are from Nos. 5203 ♀ and 5204 ♂, respectively. Scale formula, 22, 17, 15, 17; 28, 17, 17, 17; ventrals, 163, 158; subcaudals, 34, 39; upper labials, 7-7, 7-7; lower labials, 7-7, 7-7; temporals, both 1+2+3; preoculars, 1-1, 1-1; postoculars, 1-1, 1-1; anal divided; labials touch chinshields, 3-3; 3-3; total length, 517, 450 mm.; tail, 72, 73 mm.; frontal, length, width, 6.4×4.3, 5.6×3.8 mm.; parietals, length, width, 6.5×5; 5.9×4 mm.; frontal to end of snout, 6, 5 mm.; rostral visible above, 2.4, 2 mm.; eye diameter, 2.8, 2.8; eye to nostril, 3.9, 3.7. Spots on body, 40, 36; on tail, 12, 13.

The nasal is divided below the nostril only; fourteen maxillary teeth, the outer faces showing slight groovelike depressions. Ground color grayish-brown with a narrow, median, cream line interrupted by the darker brown, blackish-edged spots, the outer edges of which extend as narrow vertical lines to the third scale row; two rows of small, black flecks on first and second scale rows; below, cream; yellow on throat. A few subcaudals blackish.

Xenodon angustirostris Peters

(Plate XXIII, fig. 4)

Xenodon angustirostris Peters, Monatsb. Akad. Wiss. Berlin, 1864, p. 390 (type description; type locality, Veragua, Guatémala); idem. 1873, p. 607 (three specimens "Camaron, Provinz Chirique"); Cope, Journ. Acad. Nat. Sci. Philadelphia, (2), VIII, 1876, p. 141 (Sipurio, Costa Rica), p. 157 (Camp Mary Caretta, Nicaragua); and Bull. U. S. Nat. Mus., No. 32, 1887, p. 76; Günther, Biologia Centrali-Americana, Rept. Batr., Feb. 1894, p. 114.

Xenodon sp. Müller, Verh. Nat. Ges. Basel VI, 1878, pp. 663-666 "Costa grande gegend von Mazatenago, Guatemala."

Xenodon rhabdocephalus (*part.*) Günther, Biologia Centrali-Americana, Rept. Batr., Feb. 1894, p. 114, Amula, Guerrero; British Honduras; San Gerónimo, Guatemala; Gadow, Proc. Zoöl. Soc. London, June 6, 1905, p. 233.

Xenodon colubrinus Boulenger, Cat. Snakes British Mus., 2d Ed., II, 1894, pp. 146, 147, (*part.*); Stuart, Mus. Zoöl. U. of Michigan, Misc. Publ., No. 29, Oct. 1, 1935 (8 spec. La Libertad, Guatemala).

Ophis=(*Xenodon*) *colubrinus* Wettstein, Sitz. Akad. Wiss. Wien, abt. 1, 143 Bd. ½ Heft, 1934, p. 35 (Costa Rica).

We are uncertain as to what name is the proper one to apply to the species of *Xenodon* occurring in Mexico. Günther *loc. cit.* (Feb. 1894) placed specimens from Guatemala, British Honduras and Mexico under the name *Xenodon rhabdocephalus* Wied, and recognized *Xenodon angustirostris* Peters as a distinct species without having seen a specimen. He believed that *Xenodon bertholdi* figured by Jan (*loc. cit.*) is not from Mexico, but from Brazil, and identical with *Xenodon colubrinus* Günther.

Boulenger, 1894, referred *Xenodon rhabdocephalus* (*part.*) Günther, *bertholdi* Jan, *angustirostris* Peters and *bipraeocularis* Cope to the synonymy of *Xenodon colubrinus* Günther, referring to it sixteen

specimens from localities ranging from Para, Brazil, to Amula, Guerrero, Mexico.

Cope (1876, *loc. cit.*) referred specimens from Central America to *Xenodon angustirostris* Peters (as did Bocourt, *loc. cit.*). He regarded this form as a subspecies of *Xenodon severus* Linné.

Schmidt (Smithsonian Misc. Coll., 89 No. 1, 1933, p. 16) referred Panama specimens, which he examined, to *Xenodon colubrinus*. These specimens, four females have combined ventral—subcaudal counts ranging from 191 to 198; Boulenger's specimens from Panama have totals of 193; his specimens from Columbia range from 190 to 202. Stuart (*loc. cit.*) referred three specimens from La Libertad, Peten, Guatemala, to the same species. These specimens have total counts of 167 and 171.

Granted that specimens from Panama and Columbia are correctly referred to *colubrinus*, we find that the total counts range from 190 to 202, with an average of 194. Those from localities to the north of Panama vary between 167 and 188, the average being 175. The type of *Xenodon angustirostris* has a total count of 188 and is approached by a specimen from Guatemala with 183. *X. bertholdi* is probably a distinct species.

Of the specimens listed by Boulenger and Schmidt, all are young or females. Stuart lists two males, one of which has the lowest ventral count (124) and at the same time the lowest ventral-subcaudal count (167); the ventral count for the second male is 125 (subcaudal count not given).

A single specimen in our collection was collected by Dyfrig McH. Forbes at Potrero Viejo, near Córdova, Veracruz, Mexico, and is, we believe, the most northern record. This specimen (No. 5207 ♀) yields the following data: Scale formula, 23-19-19-17; ventrals, 123; anal, single; subcaudals, 35; preoculars, 1-2; postoculars, 2-2; temporals, 1+2+4; four labials touch the first chinshields, which are much larger than the posterior; 15 broad bands on body, 3 on tail; frontal length, 5.8 mm.; width, 5.5 mm.; parietal length, 6.9 mm.; width, 5.7 mm.; frontal to tip of snout, 8 mm.; prefrontal length, 4 mm.; width, 4.2 mm.; portion of rostral visible above one third of distance from frontal to tip of snout.

The color is grayish since the scales have been shed, the edges of the spots nearly black, while the areas between the spots are dove gray; chin yellowish; underside of tail unspotted. Belly dull cream, flecked with very numerous ashy-brown spots; on outer edge of ven-

trals a very indistinct row of cream spots separated by darker coloration. The figure (Pl. 23, fig. 4) shows arrangement of the markings.

We are, at least temporarily, considering this Mexican *Xenodon* under the name *angustirostris* Peters, despite the fact that it has a considerably smaller count of ventrals and subcaudals.

Geophis semidoliatus Duméril and Bibron

Eighteen specimens, three from Córdova, Veracruz (Nos. 5154-6, collected by H. R. Roberts) and fifteen from Tlilapam, Veracruz (Nos. 5157-71, collected by E. H. Taylor).

The specimens present the following variation in scutellation: dorsal scales smooth in both sexes, in 15-15-15 rows; ventrals, 136 to 157 in males, 144 to 169 in females; subcaudals, 22 to 25 in females, 23 to 28 in males. Five supralabials (four on both sides of one, in which the fourth and fifth are fused); six infralabials; third supralabial enters eye; no preocular; postoculars, 1-1; supraocular present, small; two pairs of genials, the anterior much the larger; anal entire.

The dark bands on the body (excluding head) vary between 17 and 32 in number; four to six are present on the tail. In most specimens two or more of the bands are fused on the middorsal line; in some as many as six consecutive bands are fused. The dark bars are usually three or four scales long, and extend laterally a varying distance—in some specimens, terminating on the fourth scale row, but usually on the first or second; none of the bands extend onto the ventral surface; they are separated on the middorsal line usually by a width of two scales, laterally by a width of three or four. The dark bands are ultramarine in young specimens, and the interspaces are pink (*fide* E. H. Taylor's field notes), while in larger specimens the bands are very dark blue-black, the interspaces orange-red.

The light band across the temporal and parietal regions varies in width from one fifth to three fourths the length of a parietal; the broader bands have concave anterior edges.

The specimens agree with Boulenger's description (Cat. Snakes Brit. Mus., II, 1894) except that the minimum in ventral and caudal scale counts is lower and the maximum ventral count is less than indicated by that author. The first maxillary tooth is posterior to the naris, about on a level with posterior edge of the nasal.

Measurements (in mm.) and scale counts of *Geophis semidoliatus*

NUMBER.	Sex.	Ventrals.	Caudals.	Total length.	Tail length.
5171	♂	136	24	126	14.0
5165	♂	139	25	138	14.3
5164	♂	141	28	157	17.2
5160	♂	139	23	161	16.0
5162	♂	148	25	167.5	17.5
5169	♂	146	28	251	30.5
5154	♂	157	26	257	26.0
5166	♂	145	25	269	28.0
5163	♂	144	22	123	12.0
5167	♂	154	22	129	12.1
5157	♀	159	23	131	12.0
5170	♀	161	22	158	14.1
5156	♀	168	24	160.5	13.2
5155	♀	169	22	169	14.0
5158	♀	157	24	266	25.0
5168	♀	152	25	287	29.5
5159	♀	152	23	295	27.0
5161	♀	159	23	310	25.6

Geophis blanchardi sp. nov.

Holotype. EHT-HMS. No. 5194; collected about two miles southwest of Acultzingo, Veracruz, Aug. 14, 1936, by E. H. Taylor.

Paratypes. EHT-HMS, Nos. 5479-5483; topotypes.

Diagnosis. A small snake, grayish-blue above, black and orange below. Internasals and prefrontals distinct; nasal divided; an elongate loreal; no preocular; small supraocular; one postocular; fifth labial broadly in contact with the parietal; one large temporal; ventrals, 155-162, and undivided; 30-40 subcaudals.

Description of type. Rostral small, not reaching the dorsal surface of the head, distinctly broader than high; internasals small, broader than long, one third to one fourth the size of the prefrontals; the combined width equal about one half of the width of the prefrontals in front of eye, the suture between them equal to half of that between the prefrontals; prefrontals very large, entering the eye; frontal four-sided, the anterior angle very obtuse, the sides converge to form a posterior angle little less than a right angle; frontal longer than its distance from the tip of the snout; supra-

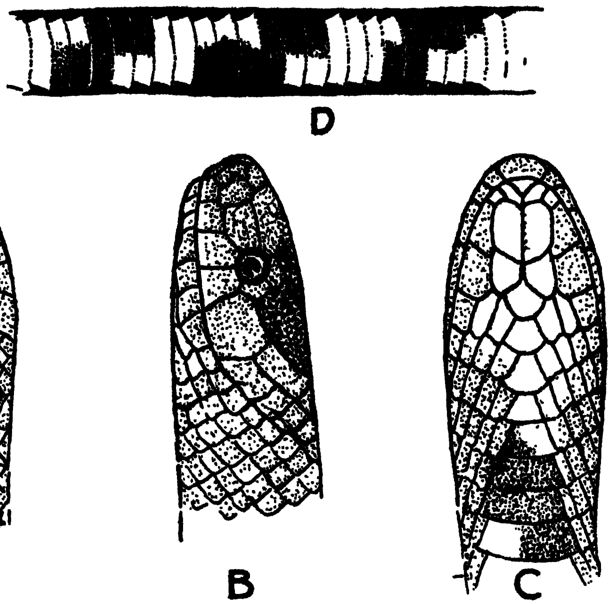

FIG. 2. *Geophis blanchardi* sp. nov. EHT-HMS, No. 5194; type, Acultzingo, Veracruz. Actual width of head, 6 mm.

oculars small, triangular, scarcely larger than the postocular; parietals elongate, longer than their distance from the tip of the snout; nasal divided into two pieces of nearly equal area, the nostril in the anterior; loreal much elongated, its length nearly twice its width; eye small, little more than half the length of loreal; six upper labials in the following ascending order of size: 1, 2, 4, 3, 6, 5, the fifth far the largest, broadly in contact with the parietal; the third and fourth enter orbit; a single elongate temporal behind the fifth labial; mental broader than long, not as wide as rostral; first pair of chinshields much larger than posterior; first four ventrals small, equal-sized, the first touching the second pair of chinshields, seven lower labials in the following order of size: 2, 7, 6, 1, 5, 3, 4; three lower labials touch first chinshield; scale formula, 17-17-17; ventrals, 162, anal single; subcaudals (paired), 130; total length, 388 mm.; tail, 46 mm.; head width, 6 mm.; head length, 10 mm.; head to end of parietal, 9 mm.

Color. Above gray-blue to blackish (where scales are shed). Below deep orange and black, the black color forming angular spots with an average length of three scales; these reach the middle of belly and usually alternate with an orange spot of about equal

size; occasionally the black spots form a band across belly; chin and neck (below) orange; lip ultramarine; a whitish spot on the edge of fourth labial.

Remarks. The relationship is with *Geophis chalybaea* and *Geophis dubius*. From the former it differs in the entirely different ventral coloration and in having a larger series of ventral scales; from *G. dubius* it differs in having a single postocular, a different lateral and ventral coloration, and a smaller series of subcaudals.

The species is named for the late Dr. Frank Blanchard in memory of his excellent contributions to American herpetology.

Enulius unicolor (Fischer)

Geophis unicolor Fisher, Abh. d. naturwiss. Vereines zu Bremen, vol. 7, 1881, p. 227 (type locality, "Mexico").

Leptocalamus unicolor Cope, Proc. Amer. Philos. Soc., vol. 22, 1885, p. 178; Günther, Biol. Cent. Amer., Rept. and Amph., 1893, p. 100.

Two specimens, both females, are available, one (No. 5237) collected four miles south of Cuernavaca, Morelos, the other (No. 5238) collected twelve miles south of Puente de Ixtla, in Guerrero.

The dorsal scales are in 17 rows; ventrals and caudals, respectively, 192 and 93 in No. 5238, 200 and 102 in No. 5237. Third and fourth supralabials enter eye; seven supra- and seven infralabials; no preocular; two postoculars; temporals, 1-2-3; three scales between the single pair of enlarged chinshields and first enlarged ventral; anal divided; scale preceding anal also divided; total length and tail length, respectively, 300 mm. and 93 mm. in No. 5238, 164 mm. and 46 mm. in 5237.

Dorsal color, light tan in the larger specimen, very slightly darker medially, the color reaching to the second scale row. In the smaller specimen the ground color is dark olive. Belly white in both specimens.

Both specimens were found under stones.

Dr. E. R. Dunn (*in litt.*) has called our attention to the fact that *Enulius** has priority over *Leptocalamus*.†

Enulius sumichrasti Bocourt

Enulius sumichrasti Bocourt, Miss. Sci. Mex., Rept., Livr. 9, 1883, p. 538, pl. 31, fig. 6 (type locality, "Isthmus of Tehuantepec"); Boulenger, Cat. Snakes Brit. Mus., II, 1894, p. 250; Werner, Zoöl. Jahrb., vol. 57, 1929, p. 148.

Enulius murinus Bocourt, Miss. Sci. Mex., Rept., Livr. 9, 1883, p. 537, pl. 35, fig. 6 (Tehuantepec specimens).

Geagras longicaudatus Cope, Amer. Nat., 1884, p. 162 (new name for *Enulius murinus* Bocourt).

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* Cope, Proc. Amer. Philos. Soc., vol. 11, 1871, p. 558 (type *murinus*, from Chinandega, Nicaragua).

† Günther, Ann. Mag. Nat. Hist., Ser. 4, vol. 9, 1872, p. 17 (type *torquatus*, presumably from South America).

One female specimen (No. 4560) was collected at night along the railroad about a kilometer from Tonalá, Chiapas.

Dorsal scales in 17 rows; ventrals, 197; tail broken; third and fourth supraoculars enter eye on one side, third only on the other; 6-7 supralabials; 7-7 infralabials; no preocular; two postoculars; temporals, 1-2-3; two or three scales between single pair of chinshields and first enlarged ventral; one loreal; anal divided, preceding scale entire; 262 mm. snout to vent.

Dorsal color dark tan, reaching to second scale row; a faint, narrow, median dorsal line of darker brown; belly, cream.

E. sumichrasti differs from the specimens referred to *unicolor* in the character of the rostral and in the shape of the frontal and prefrontals. In *unicolor* the rostral is but very slightly produced, and somewhat narrower as seen from the ventral surface. The lateral edge of the rostral is anterior to the suture between the second and third infralabial in *unicolor*, about even with the middle of the third infralabial in *sumichrasti*. In the latter species the rostral is distinctly produced anteriorly, projecting beyond the mental a distance slightly less than that between the posterior median edge of the chinshields and the median labial border of the mental. In *unicolor* the length of the rostral on the median ventral line is equal to the distance between the posterior median edge of the first infralabials and the median labial border of the mental. In the latter species, the angle between the anterior and lateral edges of the prefrontals is about 90 degrees; in *sumichrasti* the angle is considerably greater, and as a result the prefrontals are not so wide at the side as in *unicolor*. In *sumichrasti* the anterior edge of the frontal is slightly convex, while in *unicolor* it is strongly convex. The frontal is proportionately shorter in *sumichrasti*, its length not equaling its distance from the tip of the snout.

In *unicolor* the snout, in lateral profile, is distinctly down-curved, while in *sumichrasti* it more nearly approaches a straight line.

Fischer's description (*loc. cit.*) of *unicolor* is inadequate for certain identification of his species; however, the figures accompanying the description, while poor, show in general the features characteristic of the specimens here referred to *unicolor*.

E. sumichrasti was described by Bocourt as having a preocular, which character served as the basis for separation from *murinus* Bocourt (*longicaudatus* Cope, a substitute name for *murinus* Bocourt, which was stated to lack grooved teeth, present in *murinus* Cope according to Cope). However, it appears that *sumichrasti* and *longicaudatus* are synonymous, as the presence or absence of a

preocular is a variable character according to Dr. E. R. Dunn (*in litt.*), who states that it occurs on one or both sides of specimens from Mexico, Panamá and South America. *E. sumichrasti* has priority over *E. longicaudatus*.

That *sumichrasti* is distinct from *murinus* Cope (type locality Chinandega, Nicaragua) is indicated by information from Doctor Dunn (*in litt.*), who states that the two cotypes of *murinus*, and the one other existing specimen from Nicaragua, have a light nuchal collar, lacking in both *sumichrasti* and *unicolor*.

Storeria dekayi (Holbrook)

Three specimens (Nos. 4662-4), all from a locality five miles south of Valles, San Luis Potosí. All were found in piles of driftwood near a river bank.

Third and fourth supralabials enter eye; supralabials 7-7 in two, 6-7 in one (sixth and seventh supralabials fused on one side); infralabials 7-7; postoculars 2-2 in two, 3-4 in one; one preocular; loreal absent; anal divided; no scales between chinshields and first enlarged ventral.

Measurements (in mm.) and scale counts of *Storeria dekayi*

NUMBER.	Sex.	Ventrals.	Caudals.	Total length.	Tail length.
4663	♀	141	49	355	70
4664	♂	137	57	288	70
4662	♂	141	59	311	72

Storeria storerioides (Cope)

Ten specimens, from the following localities: Tres Cumbres (Tres Marias), Morelos (No. 4665); Zempoala Lake, near Tres Cumbres, Morelos (Nos. 5350-1); Desierto de los Leones, Distrito Federal (Nos. 5354-5); Rio Frio, Puebla (No. 5403); 57 kilometers southeast of Mexico City, on road to Puebla (No. 5352); 66 kilometers southeast of Mexico City, on road to Puebla (No. 5353); two miles south of San Martín, Mexico, near Zitácuaro, Michoacán (No. 5404). One specimen lacks locality data. All were found at elevations between 9,000 and 10,000 feet above sea level, in pine forests. One was found under a log, the remainder crawling about on the ground.

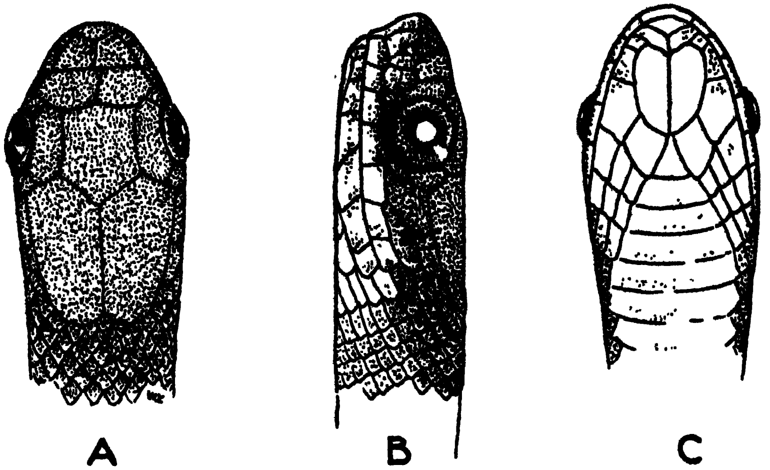

FIG. 3. *Storeria storerioides* (Cope) EHT-HMS, No. 5404; near Zitácuaro, Michoacán, in Mexico. ×5.

Scale rows 15-15-15; third and fourth supralabials entering eye, except on one side in one, in which the third only enters the eye; supralabials 7-7 in six, 6-6 in two, 5-7 in one, 7-8 in one; three preoculars, on one side in one, two in others; postoculars, 2-2 in eight, 2-3 in one, 3-3 in one; temporals, 1-1-1 in one (sides counted separately), 1-2-1 in one, 1-2-2 in ten, 1-3-2 in one, 1-2-3 in six, 1-3-3 in one; one loreal, entering orbit between preoculars on one side in one, separated from orbit in others; anal divided; second, third and fourth subcaudals entire in one specimen, remainder divided. The nasal is divided below the naris in all specimens, and is divided above the naris (apparently) in three. In eight specimens the angle formed by the two posterior sides of the frontal is 90 degrees or less, and the frontal extends posterior to a line between the posterior edges of the supraoculars. In two specimens the angle formed by the two posterior edges of the frontal is about 110 degrees, and the frontal extends posteriorly only to a line between the posterior edges of the supraoculars.

One specimen, the smallest examined (No. 5404), has the scales of the lateral row of dorsals keeled. This specimen exhibits several other variations, such as a divided nasal, a short, broad frontal with an obtuse posterior angle, and the first enlarged ventral in contact with the posterior pair of chinshields (separated by one scale in others), some of which may be due to its immaturity.

In coloration, the specimens agree with descriptions published.

It may be added that an irregular, narrow, reddish-brown band extends the length of the body on the middorsal line.

Measurements (in mm.) and scale counts of *Storeria storerioides*

NUMBER.	Sex.	Ventrals.	Caudals.	Total length.	Tail length.
4665	♀	131	47	127	26.5
5350	♀	....	45	236	47.0
5354	♀	132	46	255	50.0
5403	♀	129	46	259	52 0
5404	♂	131	51	110	23.7
5352	♂	130	49	137	29.5
5353	♂	129	50	140	31.0
5356	♂	130	50	172	39.0
5351	♂	131	53	222	51.5
5355	♂	130	51	288	64.0

Chersodromus liebmanni Reinhardt

Chersodromus Liebmanni Reinhardt, Vid. Meddel. Naturh. Forén. Kjobenhavn, 1860, pp. 243-245, Plate IV, figs. 10, 11 (type description; type locality, México).

A single specimen of this species EHT-HMS, No. 4564, was collected in a coffee plantation, 10 mi. E. of Cordova, Veracruz, July 23, 1932 (Taylor), from under a small rotten log. From under a fallen banana stem contiguous to this log was captured at the same time a specimen of *Ninia diademata* Baird and Girard. These two snakes bear a very strong superficial resemblance to each other. Both are black with yellow collars, their bodies nearly of the same thickness. Actually they are very different.

The following data are taken from No. 4564: Ventrals, 135; anal, entire; subcaudals, 34; supralabials, 7-7; lower labials, 8-8; preocular, 0-0; loreal, 1-1; postocular, fused with supraocular; temporals, 1-2; total length, 199; tail, 33.

Supranasals wider than long; prefrontals completely fused; frontal more or less triangular, as wide as long, as long as its distance from tip of snout, shorter than the parietals; nasal divided nearly equally, the nostril lying between; rostral barely visible above; five labials touch the very large anterior chinshields which are very much larger than posterior; the first labials not in contact; scale formula, 18-17-17-17. Scales are keeled dorsally, dimly anteriorly,

then becoming stronger and more evident posteriorly; the outer scale row much enlarged.

The type has 130 ventrals; subcaudals, 42; its length is 250 mm.

Ninia diademata Baird and Girard

Ninia diademata Baird and Girard, Catalogue of North America Reptiles, Part I, Serpents, 1853, p. 49. (Type description; type locality, Orizaba, Mex. Jas. Fairie coll.)

A single specimen (EHT-HMS No. 4565 ♂) was collected in a coffee plantation 10 mi. E. of Cordova, Veracruz, July 23, 1932 (Taylor), from under a banana stem, as mentioned in the discussion of *Chersodromus liebmanni.*

The following characters are evident: Ventrals, 143; subcaudals, 96; upper labials, 6-6; lower labials, 6-6; preoculars, 0-0; postoculars, 2-2; temporals, 1 + 2; scales touch chinshields, 4-4; anal, undivided; total length, 268 mm., tail, 92 mm. Rostral barely visible above; internasals about one third size of the prefrontals; latter large, entering the eye above the loreal; frontal hexagonal, as wide as long, minutely longer than its distance to tip of snout; parietals longer than frontal, equal to or a little greater than their distance from snout tip; nasal divided; loreal rectangular, entering the eye; first chinshields double size of second pair; scales very heavily keeled and striated, the formula 21-19-19-19. Outer row rather large; the others become smaller towards middle of back.

This specimen differs from the type in the absence of preoculars, and in having the prefrontals enter the orbit. It is presumed that the species is variable in these characters. So far as I can find other specimens referred to this form do not agree with the type.

The coloration is typical; the black median ventral line occupies as much area as the cream lines bordering it. Outer edges of the ventrals black.

Conophis vittatus Peters.

(Plate XXIII, fig. 1)

Conophis vittatus Peters, Monatsb. Akad. Wiss. Berlin, Oct., 1860, pp. 519-520; Pl., fig. 3; (type description; type locality uncertain): "Diese Schlange wurde bei einem Händler in Hamburg gekauft, welcher mir erzählte, dass sie nicht weit von Neu-Orleans in Mississippi mit einem treibenden Strohhausen auf ein Schiff gezogen sei."

Four specimens were taken; EHT-HMS Nos. 5149, 5150, 12 mi. S. Puente de Ixtla, Morelos, km. 133, July 14, 1936, and Aug. 1, 1936; No. 5152, km. 350, between Rincon and Cajones, Guerrero, July 24, 1936; No. 5151 Xaltianguis, Guerrero, July 27, 1936 (km. 405); Taylor collector.

The color pattern in the specimen figured is also that of the

other three specimens. The ground color is light olive or yellowish-brown. Data here given are from Nos. 5149 ♀; 5150 ♂; 5151 ♂; 5152 ♂, respectively:

Scale formula, 29, 19, 19, 17; 28, 19, 17, 17; 26, 19, 17, 17; 29, 19, 19, 17; ventrals, 165, 163, 162, 160; subcaudals, 48, 59, 70, 67; upper labials, all 7-7; lower labials, 9-9, 10-9, 9-9, 9-9; chinshields of equal length; four scales touch chinshields. Measurements in millimeters: Total length, 500, 561, 522, 552; tails, 77, 110, 133, 117; head width, 13, 12.4, 13, 13; head length, 14.2, 20, 20, 19.

One of us (Taylor) was bitten by No. 5151 on the middle joint of the third finger. Pain and swelling ensued which lasted for some time. A year and a half after the occurrence finds the digit still somewhat weak, and slightly painful when bent.

Conophis concolor Cope

Conophis concolor Cope, Proc. Acad. Sci. Philadelphia 1866, p. 318 (type description; type locality, Mexico).

H. M. Smith obtained a single specimen at Chichen Itza, Aug. 26, 1936 (EHT-HMS No. 11635). It differs from the type description in being rather olive brown. Paired dotted lines appear on back of head and for about an inch on the neck. The black stripe through the eye continues as a dim, dotted line for an inch on the neck; a dim, lighter line is suggested between first and second scale rows. Chin dark with yellow spots on posterior lower labials; upper labials with a cream line. Further data on this specimen is given elsewhere (Smith, this journal).

Tantilla rubra Cope

Tantilla rubra Cope, Journ. Acad. Nat. Sci. Philadelphia (2) VIII, 1876, p. 144 (type description; type locality, Japana, Tehuantepec, Dr. Sumichrast coll.).

This species is represented by three specimens, EHT-HMS Nos. 5240 ♂ (Radycliffe Roberts); 5241 ♀, 5242 ♂ (Taylor) from Km. 226, 22 km. N. W. of Tehuacán Puebla. Scale formula, 16-15-15, 15-15-15, 15-15-15; ventrals, 154, 156, 160; subcaudals, 66, 62, 60; upper labials, all 7-7; lower labials, all 6-6; preoculars, all 1-1; postoculars, all 2-2; temporals, all 1 + (the second lower temporal is behind last labial).

Measurements (in mm.): Total length, 348, 320, 231; tail, 88, 80, 54; head length, 11.4, 10, 9; head width, 6.5, 6, 5.7.

Superficially this species bears a rather close resemblance to *Tantilla bocourti*, but the details of the head coloration differ. The head, likewise, is black generally; the black and yellow nuchal

collars are much the same, save that the yellow collar encroaches more on the parietals; behind the eye is a more or less rounded spot of yellow, the lower border of which is formed by the black spots on the lower labials; tip of snout yellowish, with small black spots in front of nostrils and one on rostral; sometimes small spots on the outer part of the internasals.

In life the color is a light shade of brownish-red, becoming faun color in alcohol. These specimens were obtained from under cactus plants. Minute pits, comparable to apical pits of other genera, are present on the scales of this species back from the tip of the scales near the middle. These cannot be seen unless a strong lens is used.

Tantilla bocourti (Günther)

Homalocranium bocourti Günther, Biologia Centrali Americana; Reptiles, Batrachians, Jan., 1895, p. 149; (type description; type locality, "Guanajuato."); Taylor. Trans. Kansas Academy of Science, 39, 1936, pp. 336-337, fig. 1.

Five specimens are at hand: EHT-HMS, No. 5239 ♂ Cuernavaca, Morelos; Taylor, July 12, 1936, Nos. 2245 ♀, 2244 ♂, at km. 226, 22 km.; N. W. Tehuacán, Puebla; Taylor, Aug. 23, 1936, Nos. 14430 ♂, 14431 ♀, Cuernavaca, Morelos; H. M. Smith, Oct. 17, 1936.

The ventral and subcaudal counts of these specimens are, respectively, 174, 57; 173, 46; 164, 58; 177, 54; 185, 47. The specimens from Cuernavaca are generally darker than those from Tehuacán, and with a higher ventral-subcaudal count. From data here given, and published data, the following ventral-subcaudal counts obtain. The type has a total count of 227 (Guanajuato); Magdalena, Jalisco, 228-238; Cuernavaca Morelos, 231-234; Tehuacán, Puebla, Acultzingo, Veracruz, 219-221. An east-west range of from 238 to 219 is discernible.

Tantilla calamarina Cope

Tantilla calamarina Cope, Proc. Acad. Nat. Sci. Philadelphia, 1866, p. 320; (type description; type locality, Guadalajara). Taylor, Trans. Kansas Acad. Sci. 39, 1936, pp. 346-347, fig. 5.

A specimen collected four miles S. Cuernavaca (EHT-HMS No. 5243 ♀) has a broader head than the specimen from Queseria, Colima, figured by Taylor, *loc. cit.* Ventrals, 130; subcaudals, 27; upper labials, 6-6; lower labials, 6-6; preoculars, 1-1; postoculars, 1-1. Temporals, 1 + 2; mental touches chinshields; temporal in contact on both sides with the postocular. Total length, 202 mm.; tail, 27 mm.

Three dim, blackish stripes, one median, the outer on third and fourth scale rows, the space between forming slightly lighter lines.

Stenorhina degenhardti quinquelineata (Hallowell).

(Plate XXIII, fig. 2)

Microphis quinquelineata Hallowell, Proc. Acad. Nat. Sci. Philadelphia, 1854, p. 97; (type description; type locality, Honduras).

A specimen (EHT-HMS, No. 4567 ♀, Totolapam, Oaxaca, Aug. 6, 1935, H. M. Smith) of a form agreeing in detail with the characters given (and figured) for *quinquelineata* by Hallowell, causes me to resurrect Hallowell's name. It differs from *fremenvillei* in having a broad median black line, and two narrow, lateral black lines on each side; the ground color between the dark lines is a putty-gray, the edges of the scales slightly darker. Between the median and upper lateral lines is an indistinct dotted, dark line; below uniform yellow. The lips are bright yellow, without spotting.

Compared with the form *apiata* this snake has a shorter snout, the prefrontals and internasals distinctly shorter; the snout is actually broader; and the frontal is narrower and more elongate.

The specimen presents the following characters: Ventrals, 175; caudals, 34; scale formula, 24, 17, 17, 17; upper labials, 7-7; lower labials, 7-7; 3 labials touch anterior chinshields; one labial touches second chinshields; 3d and 4th labials enter eye; part of rostral visible above, equal to three fourths its distance from the frontal; latter elongate a third longer than its distance from the end of the snout; outer anterior corner of the parietals segmented, forming a second anterior "temporal"; diameter of eye equals the distance to nostril (in *apiata* much less); nasal segmented, the anterior moiety fused with the internasals; loreal wanting; preocular touching posterior nasal; 1 preocular, two postoculars; temporals, 2-2.

Total length, 465 mm.; tail, 60 mm.; head width, 11 mm.; head length, 15 mm.

Stenorhina degenhardti apiata Cope

Stenorhina degenhardti apiata Cope, Journal Acad. Nat. Sci. Philadelphia, (2) VIII, p. 142; (type description; type locality, Tehuántepec) Sumichrast, collector.

This form is represented by a specimen (EHT-HMS, No. 5153) collected five miles north of Acapulco at Puerto Crucita. The specimen was bright pinkish-red above; the ventral surface of a similar color, but of a lighter shade. There is an indistinct dark line behind eye, and a trace of a median dorsal line on the neck. In alcohol the snake has become light brown, and where the scales are

lost it is nearly flesh color. The upper labials are bright yellow, the chin and lower labials creamy-yellow. Scale formula, 24, 17, 17, 17.

The accompanying figure shows scale relationships. Ventrals, 172; subcaudals, 32; anal divided; total length, 490 mm.; tail, 65 mm.; head width, 10 mm.; length, 15.2 mm.

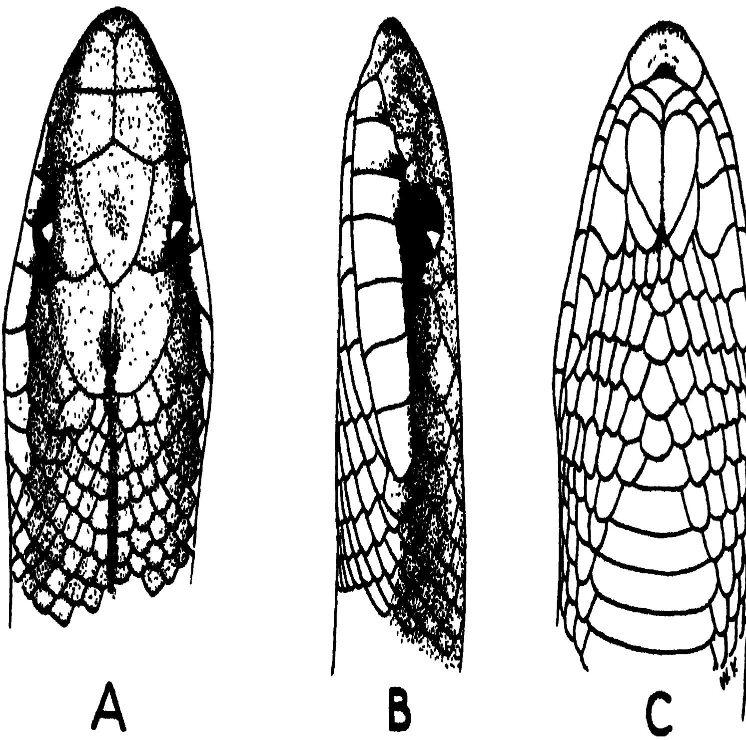

FIG. 4. *Stenorhina degenhardti apiata* (Cope). EHT-HMS, No. 5153; five miles north of Acapulco. Actual head width, 10 mm.

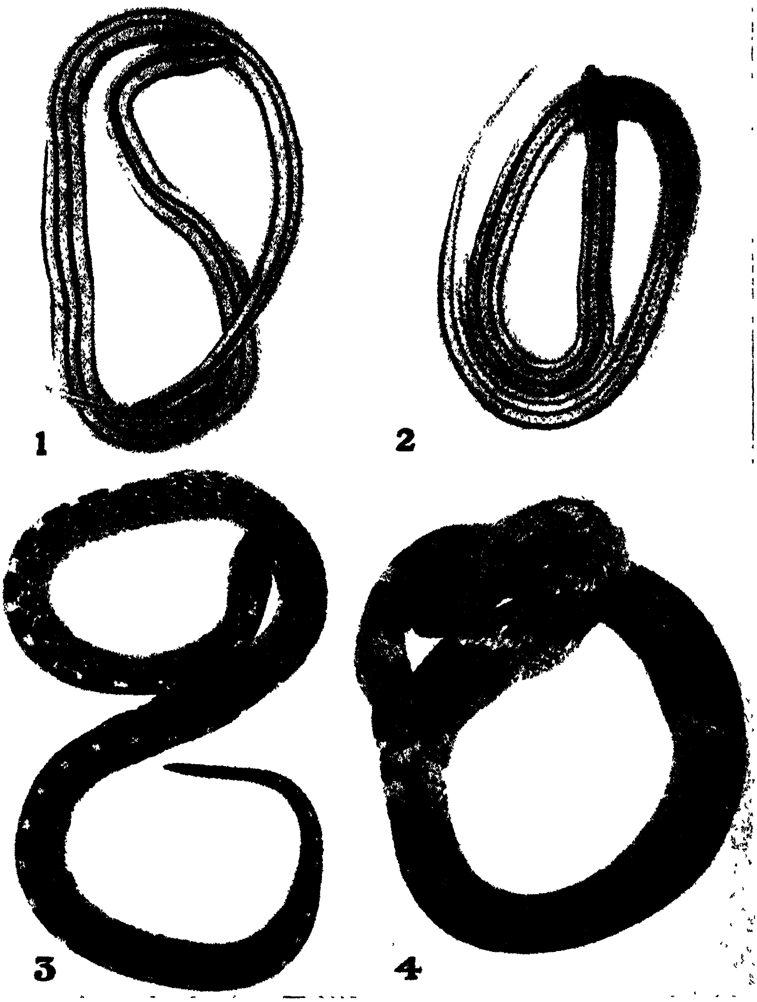

PLATE XXIII

FIG. 1. *Conophis vittatus* Peters. EHT-HMS, No. 5149 ♀; total length, 500 mm.

FIG. 2. *Stenorhina degenhardti quinquelineata* (Hallowell). EHT-HMS, No. 4567 ♀; total length, 465 mm.

FIG. 3. *Conopsis frontalis* (Cope). EHT-HMS, No. 5203 ♀; total length, 570 mm.

FIG. 4. *Xenodon angustirostris* Peters. EHT-HMS, No. 5207 ♀; total length, 587 mm.

Clelia clelia (Daudin)

Coluber clelia Daudin, Hist. Nat. Gen. Partic. Rept. vol. 6, year XI (1803), pp. 330-331, pl. LXXVIII.

A specimen (EHT-HMS), No. 4568 ♂, was collected by H. M. Smith at Paso del Rio, Colima. Ventrals, 211; caudals, 86; upper labials, 7-7; lower labials, 8-8; preoculars, 1-1; postoculars, 2-2; temporals, 2 + 3; anal single; scale formula, 24, 21, 17, 17, 17; preocular separated from frontal; parietals shorter than their distance to end of snout; frontal about equal to its distance to end of snout. Eye (3 mm.) shorter than distance between eye and nostril (3.6 mm.); loreal higher than long; length, 675 mm.; tail, 147 mm.; head width, 12 mm.; length, 19.6 mm. Head dark violet to violet-black; cream collar behind parietals 4 scale-rows wide; large blackish violet band behind collar.

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Concerning Mexican Salamanders

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ABSTRACT: This study is based on a large collection of Caudata made in Mexico during the years 1932-1936, chiefly by Edward H. Taylor and Hobart M. Smith. Three species are described from the collection of the Museum of Comparative Zoölogy, Harvard College.

Oedipus robertsi (Nevada de Toluca, México), *Oedipus smithi* (Oaxaca), *Oedipus altamontanus* (Morelos), *Oedipus giganteus* (Jalapa, Veracruz), *Oedipus multidentata* (San Luis Potosí), *Oedipus manni* (Hidalgo), and *Ambystoma schmidti* (México) are described as new. *Oedipus leprosus* (Cope), recently placed in the synonymy of *Oedipus cephalicus* (Cope), is revived as a valid species. The following species are discussed: *Oedipus bellii, chiropterus, cephalicus, leprosus, orizabensis, platydactylus, salvinii, lineolus, pennatulus; Ryacosiredon altamirani;* and *Gymnopis multiplicata oaxacae.*

THE present study is based on the collections made by Hobart M. Smith and myself in various localities in central and southern Mexico. Several of the species are represented by large series; some, unfortunately, by only one or two specimens or at most a small series.

Dunn, in his admirable work on the Salamanders of the family *Plethodontidae,* (1926) deals extensively with the plethodontid genus *Oedipus,* uniting with it the distinctive forms sometimes recognized under the generic designations *Oedipus* Keferstein (*Ophiobatrachus* Gray) and *Thorius* Cope. This work has been especially helpful in the study of the genus *Oedipus.*

The recent review of the Ambystomid Salamanders of Mexico by Lafrentz and Wolterstorff (Abh. Ber. Mus. Natur.—Heimatk. Natur. Ver. Magdeburg, Bd. VI, Heft. II, pp. 90-127 and 128-149, respectively), has been helpful in the study of *Ambystoma* and *Ryacosiredon.*

I am under great obligation to Dr. Thomas Barbour and Mr. Loveridge for the loan of the salamanders of the genus *Oedipus* in

the Harvard collection and for the privilege of describing three new forms.

The following recognized species are known to occur in Mexico (elevation, in feet, is an approximation):

Family *Plethodontidae*

Oedipus bellii (Gray)	lowland (?) to 8,000
Oedipus giganteus sp. nov	6,000 to 10,000
Oedipus gadovii Dunn	6,000 to 14,000
Oedipus sulcatus (Brocchi)	5,000
Oedipus chiropterus (Cope)	4,000 (?) to 11,000
Oedipus multidentatus sp. nov	? 8,000
Oedipus robertsi sp. nov	10,000
Oedipus altamontanus sp. nov	10,000
Oedipus smithi sp. nov	9,000 to 10,000
Oedipus macrinii Lafrentz	3,270
Oedipus manni sp. nov	8,000
Oedipus cephalicus (Cope)	8,000 to 13,000
Oedipus orizabensis (Blatchley)	8,000 to 12,000
Oedipus leprosus (Cope)	10,000
Oedipus platydactylus (Cuvier)	lowland
Oedipus salvinii (Gray)	lowland
Oedipus yucatanus Peters	lowland
Oedipus rufescens (Cope)	lowland
Oedipus lincolus (Cope)	lowland to 4,000
Oedipus townsendi Dunn	4,400-? 8,000
Oedipus pennatulus (Cope)	8,000 to 10,000
Batrachoseps attenuatus leucopus Dunn	lowland
Ensatina croceater (Cope)	3,600 to 7,000

Family *Ambystomidae*

Ambystoma schmidti sp. nov	about 8,000 feet
Ambystoma mexicanum Shaw	about 8,000 feet
Ambystoma dumereli Dugès	?
Ambystoma tigrinum velascoi Wolterstorff	6,500 to 7,500 feet
Ambystoma tigrinum tigrinum Green*	lowland
Rhyacosiredon altamirani Dugès	about 11,000 feet

Family *Salamandridae*

Triturus meridionalis Cope	lowland
Triturus kallerti (Wolterstorff)	lowland
Triturus torosus Eschscholtz	lowland

Order *Apoda*

Dermophis mexicanus Duméril and Bibron	lowland
Gymnopis multiplicata oaxacae Mertens	lowland

It is to be regretted that more detailed data on vertical distribution was not obtained. The value of such data is evidenced by the recent study on salamanders of Guatemala, by Schmidt (1936).

Several species names proposed or used for Mexican forms have been regarded as synonyms of previously described species.

* *Ambystoma proserpine* Baird and Girard, Proc. Acad. Nat. Sci. Phila. 1852, p. 178.

1. *Spelerpes orculus* Cope. This species has long been regarded as a synomym of *Oedipus chiropterus* (Cope), having been placed in the synonymy of that species by Cope, himself (1869). I have not examined the type.

2. *Bolitoglossa mexicana* Duméril and Bibron (1854), in part. (Erp. Gén. Atlas, plate 104, fig. 2.) is referable to *Oedipus bellii.*

3. *Spelerpes minimus* Wiedersheim. Dunn (1926), declaring it a *nomen nudum,* settles this name in the synonymy of *Oedipus pennatulus* (Cope).

4. *Spelerpes morio* Boulenger (1882), Jalapa, Veracruz (non Cope). Probably based on more than one species, but which I cannot say.

5. *Spelerpes laticeps* Brocchi (1883). The description is brief, and I am uncertain whether this species should be recognized or not. The type should be examined and redescribed. The brown color, as shown in the figure (Brocchi, p. XVIII, fig. 1), may be due to the preservation.

6. *Geotrition carbonarius* Cope (1860), Jalapa, Mexico, is apparently referable to *Oedipus platydactylus.* Boulenger (1882) places it in the synonymy of *Spelerpes variegatus* = [*Oedipus platydactylus* (Cuvier)].

7. *Spelerpes punctatum* Brocchi (1883). This has been placed in the synonymy of *Spelerpes variegatus* Gray = [*Oedipus platydactylus*], but the type should be reëxamined.

8. *Spelerpes attitlanensis* Brocchi (1883). Schmidt (1936), who examined the types, regards this a synonym of *Oedipus salvinii* (Gray).

9. *Spelerpes gibbicaudus* Blatchley (1893) Mt. Orizaba, Veracruz. This species is founded on the type specimen of *Spelerpes leprosus,* and is a synonym of *leprosus.*

Rhyacosiredon Dunn

1928. *Rhyacosiredon* Dunn, Proc. New England Zoöl. Club, Vol. X, Nov. 3, 1928, pp. 85, 86.

1930. *Ambystoma* Lafrentz, Abh. Ber. Mus. Natur-Heimatk. Naturw. ver. Magdeburg, Bd. VI, Heft. 2, 1930, p. 115.

1930. *Ambystoma* (*Rhyacosiredon*) Wolterstorff Abh. Ber. Mus. Natur-Heimatk. Naturw. Ver. Magdeburg, Bd. VI, Heft. 2, 1930, p. 142.

Dunn characterizes the genus as follows: "An Ambystomid salamander with no gills or gill slits in the adult state; lungs present; ypsiloid well developed; no free lachrymal; nasal present; adult with vomerine teeth in larval position; maxilla very small; premaxillary teeth aborted, not as long as bony edge of premaxilla;

both jaws with horny beak in adult and larva; larvae with gills with long rami; dorsal fin aborted in large larvae; eggs (ovarian) larger than those of other species, 3 mm. in diameter."

Rhyacosiredon altamirani (Dugès)

1895. *Ambystoma altamirani* Dugès, Description d'un Axolotyl de Montagnes de las Cruces (Ambystoma altamirani, A. Dugès), 1895, No. 15. Imprimerie du Ministere de "Fomento" (Type description; type locality "Manantial de los Axolotes en la Serrania de las Cruces, pertenociente al Valle de Mexico"); and La Naturaleza (2), II, 1896, pp. 459-461, pl. XIX; Lafrentz, Abh. Ber. Mus. Natur-Heimatk. Naturw. Ver. Magdeburg, Bd. VI, Heft. 2, 1930, pp. 115-120 (numerous localities in mountains near Mexico City).

1928. *Rhyacosiredon altamirani* Dunn, Proc. New England Zoöl. Club, Vol. X, Nov. 3, 1928, pp. 85, 86 (Santa Fé, Contreras 8,090 feet, Dos Rios 8,800 feet, all in the Ajusco Mountains south and west of Mexico City).

1930. *Ambystoma* (*Rhyacosiredon*) *altamirani* Wolterstorff, Abh. Ber. Mus. Natur-Heimatk. Naturw. Ver. Magdeburg, Bd. VI, Heft. 2, 1930, pp. 142-144, fig. 11.

Two specimens (EHT-HMS, Nos. 12511, 12512) in the collection were captured under logs, near a small stream flowing into Lake Zempoala, at an elevation of about 11,000 feet.

While agreeing in most characters, these two specimens differ in certain points which may be due to the age of the specimens.

No. 12511. Body with numerous distinct black spots on the dorsal and dorsolateral surfaces; head spotted likewise. Tail clouded with lighter and darker mottling; many maxillary teeth seem to be missing, there being only about six on each side, these covered with fleshy gums; six premaxillary teeth, elongate, curving. Vomerine teeth in elongate series which converge, but fail to meet anteriorly by a distance equal to more than double the diameter of the rather large choanae; each series is broken; the posterior group of six teeth is slightly curved around the posterior part of the choanae to a point nearly opposite the middle of choanae, where a break, equal to the width of a choana, occurs; the following eleven teeth form a straight continuous series.

No. 12512. Color, generally drab olive, the dark spotting not or scarcely discernible; the tail is mottled, similar to the previous specimen. Maxillary and premaxillary teeth form an unbroken series of 17 (18) teeth in each half of the jaw; the premaxillary series consists of 8 teeth.

In both specimens the limbs are very large and the body very short. Limbs when adpressed overlap the length of the arm from elbow. Metacarpal and metatarsal tubercles very distinct, large, rather close together. Twelve costal grooves; no groove behind eye; interorbital distance very wide; a skinfold on lower lip; tips of digits brownish; no enlarged mucous pores on head.

Measurements (in mm.) of Nos. 12511, 12512, respectively: Snout to vent, 68.2, 64.6; snout to arm, 25, 23.3; tail, 75, 68.5; width of head, 18, 16.5; length of head, 22, 19; axilla to groin, 33.5, 32; foreleg, 27, 24.5; hindleg, 29, 25; interorbital distance, 5.3, 5.4; eye to nostril, 4.4, 3.5; length of snout, 5.2, 4.4; eyelid, 2, 2; eye, length, 3, 3.2; between nostrils, 5.1, 5.

I believe that Dunn is fully justified in placing this form in a genus separate from *Ambystoma*.

It will be noted that these specimens display nothing that can be construed as horny beaks. There is, however, a slight deposition of keratin along the borders of the lips, which is scarcely noticeable. This condition may be due to the age of these specimens.

Ambystoma schmidti sp. nov.

Holotype. EHT-HMS No. 3999, collected 10 miles east of San Martín (Asunción) at Rancho Guadalupe Aug. 3, 1932. E. H. Taylor, collector.

Diagnosis. A very small species of *Ambystoma*, with short limbs and relatively small feet; adpressed limbs separated by three costal folds; 14 costal grooves (an axillary fold apparently wanting); length of eye about equal to the distance of the eye from the nostril; width of eyelid contained more than two and one half times in the interorbital distance; a nuchal fold; tail shorter than the head and body. Tongue with a deep median groove; series of vomerine teeth, beginning behind choanae near their posterior inner border, form an arch between choanae; two tubercles on hand and foot; four phalanges in fourth toe.

Description of the type. Head flat with trace of a canthus rostralis; nostrils nearer tip of snout than eye, the distance between them about four fifths of interorbital distance; a slight median occipital depression with very slight longitudinal swellings; a slight median dorsal groove along the middle of the back; a well-defined fold across underside of neck, continued as a groove on the side of the neck, but not continued across the dorsal surface; a groove beginning in the upper temporal region crosses the angle of the jaw and passes beneath the chin to meet its fellow from opposite side; a deep groove from eye runs back to the lateral nuchal groove, where it terminates; below the posterior part of this groove is a fold of skin terminating at the lateral nuchal groove; 14 costal folds (that in axilla apparently wanting); 12 grooves cross the abdomen; lips of anal slit swollen, the walls showing some slight foldings; limbs rather short, separated by three costal folds when adpressed; first

finger well developed, the second and third largest, of nearly same size; fourth toe much longer than first; all digits flattened somewhat with a slight skinfold along their edges; a slight indication of a web between toes; foot broad, the ascending order of length of toes, 1, 5, 2, 3, 4; toes rather bluntly pointed; tail compressed, with only a slight trace of a crest for a short distance on the base of the tail. Skin smooth, the head showing minute pitting.

Vomerine teeth in a continuous series consisting of about 16 teeth; they begin behind the choanae near the inner posterior edges and curving between choanae, fail to reach the level of their anterior edge; a median depression in the palate anterior to the vomerine teeth; groove from the choanae covered by a triangular projection from side of jaw; maxillary and premaxillary teeth about forty on each side; a few other scattered teeth behind the regular series, anteriorly.

Color. Above violet to lavender with small scattered cream spots on sides of head, body and tail; tail somewhat darkened on side; below yellow-cream, the color extending somewhat on sides; upper side of limbs somewhat lighter than body.

Measurements (in mm.). Snout to vent, 52; tail, 37; head length, 10; head width, 9.3; snout to arm, 15; axilla to groin, 28.4; arm, 12; hand and finger, 4.3; leg, 14; foot and longest toe, 7.5; eye length, 2.3; interorbital distance, 3.5; eyelid, 1.25.

Remarks. The specimen was obtained from under a log in a pine forest near a large artificial pond. It is not, apparently, closely related to the other recognized Mexican species of the genus, as evidenced by the absence of large pits on the head, and the very small limbs. The elevation of this locality is probably 8,000 feet.

This species is named in honor of Dr. Karl D. Schmidt, of the Field Museum, Chicago, who has had the kindness to furnish me with comparative salamander material from Central America.

Oedipus bellii (Gray)

(Plate XXVII; figs. 1, 2)

1849. *Oedipus platydactylus* Baird, Journ. Acad. Nat. Sci. Philadelphia, (2), 1, 1849, p. 286 (Not *Salamandra platydactylus* Cuvier).

1850. *Spelerpes bellii* Gray, Cat. Batr. grad. Brit. Mus., p. 46 (type description; type locality, "Mexico"); Cope, Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 372; and 1869, p. 105; and Proc. Amer. Philos. Soc., 18, 1879, p. 263; and idem, 1869, p. 105; Boulenger, Cat. Batr. grad. Caud. British Mus., (2), 1882, pp. 68-69; Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale, Etude sur les Batraciens, Livr. 3, 1883, p. 110, pl. 206 (*part.*); Ferrari-Perez, Proc. U. S. Nat. Mus., 9, 1886, p. 199; Cope, Bull. U. S. Nat. Mus., No. 32, 1887, p. 8; and Bull. U. S. Nat. Mus., No. 34, 1889, p. 161; Blatchley, Proc. U. S. Nat. Mus., 16, 1895, p. 37 (*Part.*); Dugès, La Naturaleza, (2), 2, 1896, p. 482; Moore, Proc. Acad. Nat. Sci. Philadelphia, 1900, p. 619; Günther, Biologia Centrali-

Americana, Rept. and Batr., 1902, p. 299; De Leon, Indice de los Batracios que se encuentran en la República Mexicana, June, 1904, p. 37; Gadow, Zool. Jahrb., 1910, pp. 709, 714.

1854. *Bolitoglossa Mexicana* Duméril and Bibon, Erp. Gén, 9, p. 93, pl. 104, fig. 2 (Oaxaca, Mexico; Veracruz, Mexico); Dugès, La Naturaleza, 1, 1869, p. 144.

1854. *Salamandra togata* Valenciennes, mentioned in Duméril and Bibron, Erp. Gén. 9, 1854, p. 94 (apparently not published).

1856. *Spelerpes Mexicana* Hallowell, Proc. Acad. Nat. Sci Philadelphia, 1856, p. 11.

1884. *Geotriton bellii* Garman, Bull. Essex Inst., 16, 1884, p. 471.

1918. *Oedipus bellii* Dunn, Bull. Mus. Comp. Zoöl., 1918, 62, p. 471; Field Mus. Nat. Hist. Zool. Ser, XII, pp. 99, 100; The Salamanders of the family Plethodontidae, Smith College 50th anniv. publ., 1926, pp. 357-360, fig. 57, map (*part.*); Wolterstorff, Abh. Ber. Mus Nat. Heimatk. Naturw. Ver. Magdeburg, band, VI, Heft. 2, 1930, p. 146.

This, one of the most striking species of the Mexican salamander fauna, enjoys a wide distribution on the plateau region, but apparently occurs sporadically. A series of specimens (Nos. 3973-3994) in the collection was taken by Hobart M. Smith and David Dunkle near Belen, 40 kilometers north of Teocaltiche, Jalisco, July 22, 1934.

Description of the species. (From EHT-HMS. No. 3981 ♂.) Large species with robust body; seen from above the head is truncate oval, flattened; eye large, longer than the snout, but about equal to its distance from the tip; the posterior parts of eyelids inserted under a fold; a groove from behind eye which joins the first gular grooves; latter short, not joining in the middle of throat; gular fold present, prominent; 13 costal grooves; three costal folds between adpressed limbs; limbs well developed, the toes, in descending order of length, 3, 4, 2, 5, 1; both fingers and toes somewhat webbed at base, flattened; tail longer than body, somewhat circular, with a basal constriction; anal lips lined with papillae (male); vomerine teeth in two elongate series, curving back strongly, medially, extending outward beyond the outer level of choanae in a straight line; series narrowly separated medially; parasphenoid teeth in two series more or less contiguous anteriorly, but separated from each other most of their length; separated from the vomerine series by a distance of little more than the width of a choana.

Color. Coal black on back and sides, somewhat grayish black below; two large orange-yellow blotches on back of the head; a somewhat inverted V-shaped spot on neck, followed by paired series of orange spots extending down to and onto base of tail, one pair corresponding to a costal fold.

Measurements of Oedipus bellii (Gray) (in mm.). Snout to vent, 93; snout to gular fold, 21; snout to foreleg, 29; axilla to groin, 53; head width, 14.5; foreleg, 21.5; hind leg, 22; head width in head-body length, 6.4 times; head length in head-body length, 4.6 times.

Remarks. A very young specimen (No. 3992), (19 mm. from snout to vent) shows only a suggestion of the dorsal coloration, many of the dorsal spots being missing; No. 3993 is practically the same. No. 3984 (45 mm.) has many of the orange spots missing on the right side, a few on the left side.

For the most part the specimens conform to the coloration and marking of the specimen described. Specimens from Guerrero, Hidalgo, have much thicker tails. The apparent differences may be due to different methods of preservation.

Distribution. Known from Jalisco, Nayarit, Michoacán, Guerrero, Oaxaca, Veracruz, Guanajuato, Querétaro, Hidalgo, and Distrito Federal. Certain records of *O. bellii* for Veracruz are referable to another species.

Larger series of this species will doubtless permit the separation of certain subspecific groups in this widespread form. The record of this species from Fort Whipple, Arizona, 3 specimens should be questioned. (Listed by Dunn, 1926, and apparently doubted by him.)

Oedipus giganteus sp. nov.

(Plate XXVII, figs. 3, 4)

1883. *Spelerpes bellii* Brocchi (*part.*), Mission Scientifique au Mexique et dans l'Amérique Centrale. Etude des Batraciens, Livr. 3, 1883, pp. 110-11, ? pl. XX bis fig. 2.

1826. *Oedipus bellii* Dunn (*part.*), Salamanders of the Family Plethodontidae, Smith Coll. Publ., 1926, pp. 357-360 (certainly MZC specimens Nos. 8434-8437, perhaps others).

Type. MCZ, No. 8435, Jalapa, Veracruz, Dr. E. R. Dunn, collector ("under rocks, around the roots of trees in comparatively open pastures").

Paratypes. MCZ, Nos. 8434, 8436, 8437. Same collector and locality; EHT-HMS, 12040, 12085, Cofre de Perote, Veracruz, Elev. 10,000 feet.

Diagnosis. The largest species of the genus, related to *Oedipus belli*, but differing in larger size, proportionally shorter axilla to groin measurement, and proportionally greater head width; pits on head well developed; large orange spots absent on occipital region; adpressed limbs separated by one fold or less in males, in the large female by three folds; a median pit in roof of mouth between choanae; vomerine teeth, 25-25; maxillary teeth, 47-45 in males; 4 premaxillary teeth pierce the lip in males; 68-72 maxillary-premaxillary teeth in female; 62-62 mandibular teeth in males; parasphenoid series fused together anteriorly, diverging strongly posteriorly.

Description of the type. Adult male. Head broader than neck;

snout truncate, the nostrils widely separated; subnarial swellings very moderate; interorbital region somewhat depressed, flattened; eye (4.9 mm.) about equal to length of snout (4.8 mm.); smallest interorbital distance (4.2 mm.) about equal to width of eyelid; width between nostrils, 7.8 mm.; width of head (17 mm.) contained in distance between snout and posterior part of vent (110 mm.), 6.4 times; head length (19 mm.) in same distance, 5.8 times; dorsal surface of head and eyelids with well-developed pits, closely placed, giving the skin a somewhat corrugated appearance; posterior corners of eyelids fitting under a diagonal fold of skin; maxillary teeth, 47-45; premaxillary teeth, four visible, piercing upper lip; mandibular teeth, 62-62; vomerine teeth in two arched series of 25 teeth each, separated medially by a distance less than width of choanae, extending much beyond choanae; parasphenoid teeth in two groups, contiguous anteriorly, diverging posteriorly (length of series, 8.5 mm.; posterior width, 6 mm.) separated from vomerine series by a distance more than a third the distance between choanae. A very large hedonic gland on chin, 8.2 mm. wide.

Skin of body smooth dorsally and ventrally, slightly wrinkled laterally, the pits more or less evident over most of body; costal folds, 11, not counting an axillary which is not apparent in specimens examined; a strong fold on neck, with lateral grooves which meet at an angle on neck; vertical groove at angle of mouth which can be traced across throat; a strong longitudinal fold from eye to nuchal groove; tail subcircular in outline not, or scarcely, compressed, the vertical grooves on sides fairly distinct (22 in evidence), the dorsal surface corrugated and roughened, below perfectly smooth; the complete but dissevered tail measures 110 mm., which is exactly the measurement from tip of snout to the back part of vent. (In younger specimens tail distinctly shorter than body, and distinctly compressed laterally, with tail strongly constricted at base.) Glandular spot present behind insertion of femur; limbs heavy, the digits terminating in the calloused tips which give them a somewhat truncate appearance; ascending order of size of fingers, 1, 4, 2, 3; fingers free save for a very minute but distinct web; first finger smallest and very short but definitely extending beyond web; order of size in toes, 1, 5, 2, 4, 3; first toe is very narrow and short, only extreme tip free. Arm brought forward; the longest finger reaches the posterior corner of eye; when limbs are adpressed the toes are separated by the width of a costal fold (in large female by about three folds); lateral fold caused by extension of a hyoid cartilege

terminates at about third or fourth costal fold; sides of anal slit, with numerous papillae (in females sides of slit folded).

Color in alcohol. Above slaty to grayish-black, of a somewhat lighter shade below and somewhat darker laterally; a small V-shaped orange spot behind the groove crossing neck followed by 15 pairs of orange spots on back which terminate abruptly at tail; latter uniform gray slate; tips of digits somewhat lighter than remainder of hands and feet.

Variation. In MCZ 8436 ♀ the dorsal spots are less distinct posteriorly and are smaller throughout with less definite outlines; there are traces of yellow flecks anterior to the dorsal nuchal groove, while dorsal and lateral surfaces of the head have numerous brown spots; a few spots evident on back. A younger specimen, MCZ No. 8437, likewise shows the minute brown spotting. This latter specimen has the first three orange spots on each side confluent and the pairs of dorsal spots are closer together, anteriorly, than in type; the dorsal ground color has more brown and the ventral surface is a dull grayish-brown. The pigment is less dense on venter, showing a cream ground color, especially under hind limbs. The tail, however, is slate-black above and below in sharp contrast to body color. A young specimen (MCZ 8434) has the entire dorsal series more or less confluent, forming two irregularly-edged stripes on the back. In a very young specimen, EHT-HMS No. 12085 (snout to vent, 9 mm.), the spotting is scarcely visible; the head is rugose, the color blackish.

Variation in measurements and proportion are shown in the table.

Relationship. The relationship appears to be with *O. bellii*, *O. robustus*, and *O. schmidti*, the first two being characterized by orange dorsal spots or flecks. It has obviously been confused with *O. bellii* in the literature. The most salient characters by which the two may be separated is the heavier pitting of the skin, weak or wanting in *O. bellii*, the proportionally wider head in specimens of equal length (or very much greater body length in specimens of equal head size); large series of teeth (maxillary, mandibular and vomerine) in adults of *giganteus* and the absence of the large occipital yellow or orange spots. It appears to reach a distinctly larger size than *O. bellii*.

It has been impossible to separate completely the literature references to *O. bellii*, that may refer to this form. I suspect that this species is confined to the eastern part of the plateau, while *O. bellii* has a much wider distribution on the plateau. Specimens mentioned

by Günther (Biol. Cent. Amer. 1901, p. 299) from Omilteme in the Sierra Madre del Sur in Guerrero should be carefully reëxamined, since it is possible that still other species are masquerading under this name.

Table of measurements in mm. and data of *Oedipus giganteus*

Number	8436	8435	8431	8434	12085
Museum	MCZ	MCZ	MCZ	MCZ	EHT
Sex or age	♀	♂	♂	yg.	yg.
Snout to back end of anal slit	128.5	110	73	46	19
Length of snout	5	4 8	3 3	3	1 5
Snout to arm insertion	38 4	34 2	23	13 5	7
Head length to jaw angle	22 5	19	14	10 2	4 5
Head width	21	17	12 5	9 2	3 7
Eye length	7	4 9	4 4	3 6	1 5
Axilla to groin	66 5	56	34 2	22 5	9 5
Arm	26 26	24 26	17	12	5.8
Leg	26-26	26.5 27	18	12 6	6
Tail		*110	54	23 5	11 6
Costal grooves	11	11	11	11	11
Legs separated by costal folds	3	1	½	0	Overlap one fold.
Head width in head-body length	6 01	6 4	5 8	5	5
Maxillary-premaxillary teeth	67 68	49 47	44-44	35-39	
Vomerine teeth	29-30	25-25	22-22	16-14†	
Mandibular teeth	67-?	62-62	42-43	34-35	

* This dissevered tail is in the jar with two tailless specimens. It appears to belong to No 8435, but if it should actually belong to the other, No. 8436, it would show that the tail is not as long as body.

† Tooth row very irregular.

Oedipus smithi sp. nov.

(Plate XXV, figs. 5, 6)

Holotype. EHT-HMS No. 3966 ♀, collected by Hobart M. Smith, Cerro de San Luis, 15 mi. N. W. Oaxaca, Oaxaca, Aug. 5, 1935.

Paratypes. 3965-3969 same data as type. Nos. 15616-15641, Cerro San Felipe, 15 mi. N. W. Oaxaca, Aug. 20, 22, 1938, Taylor.

Diagnosis. A large salamander, dark brown above; below slaty gray, with a tinge of red on lighter brown at sides; 13 costal grooves, those in axilla and groin rather indistinct; the edges of the grooves darker so that there appear to be 13 dark vertical stripes on side; 3½ to 4 costal folds between adpressed limbs; vomerine teeth in

two long, greatly curved series of 12-14 teeth, beginning 1.5 mm. behind a line drawn between posterior edges of choanae and curving up and out beyond the outer edges of choanae; parasphenoid teeth in two series, narrowly separated anteriorly, but separated by 1.8 millimeters posteriorly; each series six millimeters long.

Description of type. Head rather broad, lacking canthus; nostrils at tip of snout which is truncate; snout extending slightly beyond mouth (.8 mm.) (in male, 1.5 mm.); upper surface of snout slightly convex; a strong medial groove begins at a point between eyes and passes back on neck; inner border of eyelid bordered by a distinct curving groove; parietal regions swollen strongly; head length in snout to vent length, 5.6 times; head width in snout to vent length, 7½ times; eye to tip of snout (3.1 mm.) much less than length of eye (measured from corners of lids, 4 mm.); outline of upper jaw, slightly undulant, seen from side, not straight; angle of jaw much behind posterior angle of eye, both eyelids fitting under a fold of skin behind; a groove from eye curves back and somewhat down along side of neck to beyond the gular fold; first gular groove rather indistinct, somewhat behind jaw angle; arm well-developed, the digits webbed for nearly a third of their length, the web continued to tips as a slight dermal fringe; the first finger very short, not completely involved in web; the descending order of length of fingers, 3, 2, 4, 1, the second and fourth of nearly equal length; toes with a small web at base, and lateral dermal fringe to tips; 3, 4, 2, 5, 1, the order of length of toes; tail (76 mm.) longer than snout-to-vent measurement (68 mm.), constricted at base, compressed somewhat laterally; anal lips with grooves and folds, without papillae; a well-defined gular fold; vomerine teeth in two curved series each consisting of 12 (13) teeth, curving forward and out beyond outer edge of the choanae, separated by 1 mm. from the parasphenoid teeth; latter in two series beginning at hinder level of maxillary teeth, narrowly separated anteriorly where they are very narrow, widely separated posteriorly where the series is widest; about 19 diagonal rows in each series; 20-22 maxillary teeth; six or seven premaxillary teeth; 24 mandibular teeth.

Color. Above dark brown; sides somewhat yellowish or grayish olive-brown tinged with red in life, with a series of thirteen vertical, blackish bars on side between axilla and groin; chin and under tail cream with a peppering of cinnamon-brown; belly grayish-cream with traces of darker lines following costal grooves; sides of tail with numerous blackish spots; lips and side of neck cream, peppered with cinnamon-brown.

Variation. There appears to be practically no variation of import as regards color and markings; No. 3965 has the lateral vertical black bars continued across abdomen. In the others the ventral bars are only faintly indicated.

All the males have a very clearly defined gland on the anterior part of chin which is flat, somewhat salient, 4.5 mm. long, 5 mm. wide. This is almost without pigment and is in strong contrast to its surroundings. In the males there are 4 to 6 premaxillary teeth which pierce the upper lip; the total number of teeth, however, is about the same as in the female; fourteen is the maximum number of vomerine teeth. The tails on the males are somewhat thicker, heavier and a little shorter; the anal walls are strongly papillate; the snout projects 1.5 mm. beyond mouth in the larger males; the head is proportionally wider in males. The head length, in snout-to-vent length, being 5; the head width in same being 6.3 times, in No. 3970. A semicircular fold under tongue of all.

Table of measurements of *Oedipus smithi* sp. nov.

Number	3966	3965	3970	3968	3969
Sex	♀	♂	♂	♂	♂
Snout to vent	69	69	72	67.5	59
Tail....	76	70	69 5	70.5	66.3
Head to arm..	20	22	22.2	21.8	18.3
Head length	12	14.5	14.8	15.4	12 5
Head width	9	11	12	11.2	9
Arm....	13 5	13 6	14.9	13.1	13.3
Leg....	16	15.4	16	16 5	14.3
Axilla to groin	39	38.3	42	38.5	33.3
Interorbital width	2.5	2.2	2.4	2 2	2
Snout	3	4	3 8	3.7	2.9

Remarks. This entire series of specimens was collected by Dr. Hobart M. Smith. The following data are from his diary. Color in life: "Below, dull-colored, slaty-gray; above very dark brown, lighter on sides with a tinge of red. All were found under planks and cut logs, covered with leaves, but never very deeply covered. Forest with many pines and other evergreens, with much moss on the trees—a sort of rain forest, very damp. Taken about 200 feet from the summit of the peak of Cerro de San Luis, about 15 miles (by the road) north of Oaxaca. The elevation must have been about 9,000 or more feet."

Apparently the species is not closely related to any other Mexican *Oedipus*, with the possible exception of *O. sulcatus*, from which it differs in the much larger size, longer tail, larger series of vomerine teeth, a much greater width between adpressed toes and a very distinctly different color pattern. *O. sulcatus* has been reported from Cerro de San Felipe, Oaxaca.

The species is dedicated to Dr. Hobart M. Smith, the discoverer of this form, in recognition of his researches in Mexican herpetology.

Dunn's reference, of 2 specimens from this locality, to *sulcatus* is not wholly conclusive. However, the comparison given is with his description, since I have not seen the type. The feet of Dunn's specimen (U. S. N. M. 47606) differ from Brocchi's figures. (Miss. Sci. au Mexique. Batrach. Liv. 3.1883 Pl. XX, fig. 2.)

Oedipus altamontanus sp. nov.

(Plate XXV, figs. 3, 4)

Holotype. EHT-HMS No. 12245; collected at Lake Zempoala, Morelos, Mexico, Aug. 6, 1936, by E. H. Taylor; elevation 10,500 feet.

Paratype. EHT-HMS No. 12239. Same data as type.

Diagnosis. A medium-sized species with a rather large head; vomerine teeth in two series of 10 teeth rather widely separated medially, curving, extending beyond outer level of choanae; maxillary teeth large, about 22 in maxillary-premaxillary series; mandibular teeth same; hedonic gland on chin of males scarcely discernible externally; arms and legs well developed, touching when adpressed; a trace of a web; 12 costal folds, that in axilla very indistinct. Purplish with cream flecks on body; head width in snout-to-vent length, 6.07; head length in same, 4.7; snout to vent, 48.6 mm.; tail, 47 mm.

Description of the type. Head flat between orbits, but surface somewhat roughened, the snout rounded in dorsal profile; canthus rostralis lacking or greatly rounded; a slight depression from anterior angle of eye toward nostril, below which the lores are more rounded; nostrils almost terminal, the distance between them about equal to the interorbital width; width of eyelid a little less than interorbital distance (equal in paratype); posterior ends of eyelids fitting under a fold; length of eye greater than length of snout; a deep longitudinal groove from eye back to the ends of the well-defined gular fold; first nuchal (or head) groove crosses behind angle of mouth, intersects the longitudinal groove, and is continued

some distance above, not crossing chin below; 12 costal folds, that in axilla dim, none indicated in the groin; a slight indication of a broken median dorsal groove not reached by the costal grooves; 9 costal grooves continue across belly; anal region much swollen, the papillae showing deep in the cloaca; arms and legs strong, elongate; very slight webbing indicated; first finger very short, the tip barely free; fourth finger shorter than second; third much longer than second; first and fifth toes very short on left foot, on right the fifth is considerably more elongated; the order of size is 1, 5, 3, 4, 3. A slight web is indicated; tips of digits swollen on under surface; skin of head pitted, minutely corrugated; on body, back rather smooth, the sides wrinkled, belly smooth with fine transverse grooves or wrinkles; hedonic gland barely visible externally; a small glandular area present behind and a little above insertion of hind leg.

Vomerine teeth in two curved series of 10-11 teeth separated by a distance equal to one and one half times the width of a choanae, extending much beyond outer level of choanae; palatine teeth in two series contiguous anteriorly, diverging and widening posteriorly, separated from the vomerine series by a distance equal to three or four times width of choanae; three or four premaxillary teeth pierce the lip; 22-23 teeth in maxillary-premaxillary tooth series; about same number of mandibular teeth.

Color. Head and body generally purplish-violet with a lighter brownish-lavender clouding along the dorsal surface; cream-lavender on sides; ventral surfaces nearly uniform purplish violet (paratype has creamy flecks on chin and breast, scarcely discernible in type); on the dorsal surface of the proximal parts of the limbs are creamy areas or spots, these are less distinct on the sides and dorsum of the distal part of limbs; lower eyelid grayish.

Measurements (in mm). and data of the type and paratype, respectively. Numbers 12245, 12239; sex, ♂, ♀; snout to vent, 48.6, 40; snout to arm, 15, 14.1; axilla to groin, 27, 23; width of head, 8, 7; length of head, 10.2, 8.5; foreleg, 13, 11.3; hind leg, 16.6, 12; head width in snout-to-vent length, 6.07, 5.7; head length in same, 4.7; 4.7; length of eye, 3, 2.6; length of snout, 2.8, 2; interorbital width, 2.2, 1.9; width of eyelid, 2, 1.9; distance between nostrils, 2.3, 2; snout to gular fold, 11.6, 8.9; tail, 47, (?).

Remarks. This species belongs in the group having fingers nearly free, which includes *leprosus* and *robertsi,* but differs from these species in the larger maxillary teeth; the reduced number in the maxillary-premaxillary series; the longer, stronger limbs; the re-

duced condition of the fifth toe; and the peculiar coloration clearly distinguish this species from other members of the genus.

The specimens were collected at about 10,500 feet elevation. I suspect that it will be found to be a species restricted to the highest peaks in the region.

The types were found on grass which was partly covered by logs. In life the violet-purple color with the cream markings and mottling is very striking.

Oedipus leprosus (Cope)

(Plate XXIX, fig. 2)

1869. *Spelerpes leprosus* Cope (*part.*), Proc. Acad. Nat. Sci. Philadelphia, 1869, p. 105-106 (type description; type locality, Orizava, Mexico, F. Sumichrast, coll.).

1893. *Spelerpes gibbicaudus* Blatchley, Proc. U. S. Nat. Mus., XVI, 1893, pp. 38-39 (same type as *S. leprosus*).

1926. *Oedipus cephalicus* Dunn (*part.*), The salamanders of the family Plethodontidae, Smith Coll. Publ. 1926, pp. 380-384, (USNM 19255; type of *gibbicaudus*; MCZ 7659 Xometla, Gadow, coll.).

(I have not attempted to allocate all the various literature references to *O. leprosus*, since without an examination of the material on which each report is based such allocation would perforce have to be made largely on conjecture.)

A reëxamination of Cope's type and paratypes of *Spelerpes leprosus* have led to the surprising discovery that no less than four species were present in the original lot. Of the original six specimens, five still remain; the smallest, mentioned in the type description, is lost. ("Like other Mexican *Spelerpes*, this animal seems to pass its metamorphoses early; a young one sent with the adults measures 21 lines [about 46 mm.] in length.")

In the original type description, which is a composite one, Cope designates as a type a specimen whose measurements are given. This specimen now bears the number USNM 19255, and is likewise the type of *Spelerpes gibbicaudus* Blatchley. This name, therefore, is a synonym of *O. leprosus* (Cope).

Among the four remaining, one (now USNM 123591) is a specimen belonging to *Oedipus cephalicus* (Cope). The identity of another (now USNM 123592) is still in doubt. The two remaining specimens still bearing the USNM No. 6340 are conspecific and may belong to an undescribed form.

The exact elevation on Orizaba, at which the type was collected, is not known. Sumichrast states that it was confined to the "Alpine region." I have recently examined a specimen which I believe belongs to this species (MCZ No. 7659, collected by H. Gadow at

Xometla, Camp) which was obtained at an elevation of 10,000 feet on Mt. Orizaba. It presents the following characters:

Adult male. Head not flattened, the dorsal surface of snout curving, sharply truncate in front, somewhat angular, due to moderately prominent subnarial swellings; eyes very prominent; body more or less cylindrical; pitting on skin dim, the skin more or less corrugated; the corrugations distinct behind eye; length of eye (3.2 mm.) a little less than length of snout (3.7 mm.); interorbital distance (2 mm.) about equal to width of upper eyelid (2.1 mm.); distance between nostrils, 3.2 mm.; between choanae, 2 mm.; head width (7 mm.) contained in snout-to-vent length (57 mm.) 8.1 times; head length (11 mm.) in same distance, 5.1 times.

Skin above generally smooth, with very fine, short wrinkles visible under the lens; sides and venter smooth, the 11 costal folds moderately distinct, the axillary and inguinal folds not apparent; a whitish glandular area behind insertion of femur; neck rather constricted (normal?), the nuchal fold present, with lateral grooves meeting at an angle on dorsal side of neck; a groove passing across angle of jaws cannot be traced completely across chin; a well-defined groove from behind eye to nuchal groove; skin bordering this groove somewhat pustular; anal slit bordered with papillae.

Limbs well developed, but separated when adpressed by a distance equal to slightly less than width of three costal folds; ascending order of length in fingers, 1, 4, 2, 3; the digits wide with a distinct but very short web; tip of first finger free; web involves about half of the proximal phalanges and is continued along the edge somewhat on the middle finger; ascending order of size in toes, 1, 5, 2, 4, 3, the web slightly evident, involving half of the proximal phalanges on third and fourth toes; tips of digits moderately inflated, but not widened at tip; arm, brought forward, fails to reach the eye; tail missing. A large hedonic gland on chin 3.2 mm. by 2.5 mm.

Parasphenoid teeth in two groups, separated throughout, diverging and widening somewhat posteriorly; length, 5 mm.; combined posterior width, 2.4 mm., separated from vomerine teeth by a distance equal to half the distance between choanae; 13-14 vomerine teeth in nearly transverse series, curving back slightly, medially, separated by a distance not larger than diameter of choanae; a small pit between choanae; 36-37 maxillary-premaxillary teeth; about four premaxillary teeth pierce lip; 42 mandibular teeth on one side.

Color in alcohol. Above, ground color slate with grayish clouding or blotching on dorsal surfaces and sides; laterally the costal grooves show as brownish lines; uniform slate below; limbs lighter with grayish blotches; underside of hands and feet yellowish-cream; snout creamy with thin scattering of pigment, absent or nearly so on subnarial swelling and lips; lower eyelid cream edged with black; upper eyelid edged with cream; chin largely cream with minute scattering of darker pigment and a cream spot across throat at fold.

Measurements. Snout to posterior border of vent, 57 mm.; snout to arm insertion, 17 mm.; axilla to groin, 30.4 mm.; head length, 11 mm.; head width, 7 mm.; arm, 11.8 mm.; hind leg, 13 mm.

Variation. The description of *Spelerpes gibbicaudus* by Blatchley offers some details on the type of *Spelerpes leprosus* Cope. My examination of the type shows the proximal phalanges of the middle toes and fingers to be involved nearly half their length in the skin (web); the groove behind the eye is only dimly visible. The type description by Blatchley states that the toes are unwebbed. The pitting on the skin is minute and minute wrinkles are visible. Twelve costal folds can be counted; 24 grooves visible on tail; maxillary-premaxillary teeth, 32-32; vomerine teeth, 12-12. Brownish coloration mentioned by Blatchley is apparently due to preservation. Chin cream with a meager scattering of pigment; head lighter than body, the tip of snout nearly all cream; lips cream and eyelids with some cream color; below, brownish slate; grayish on top of tail and dark below.

Measurements (in mm.) of the type of *Spelerpes leprosus* given by Cope (reduced to millimeters); of the same specimen as given by Blatchley in his description of *Spelerpes gibbicaudus;* and my measurements of the same specimen, respectively: Snout to posterior end of vent, 50.8, 46 (may be only to front end of vent), 48.5; total length, 88.9, 85, 87; tail, 38.1, 38.5, 39; axilla to groin, 29.4, 26.3, 31; arm, 10.5, 10, 10; leg, 10.9, 10.7, 11; head width, 7.6, 7, 6.33 (this measurement varies if the mouth, which has been forced open, is not completely closed).

I suspect that the slight differences in measurements are due merely to different techniques in measuring. The specimen now has the tail severed. None of the other specimens in the series approaches closely the measurements given by Cope for the type.*

* Certain workers have stated that they do not believe a type has been indicated by Cope. While I regard the act needless, I hereby designate the presumed type (now, USNM No. 19255) as lectotype.

Oedipus manni sp. nov.

(Plate XXIX, figs. 4, 5, 6)

1918. *Oedipus leprosus* Dunn, Bull. Mus. Comp. Zoöl., 62, 1918, p. 470. (Harvard specimens 3912-3930), Guerrero, Hidalgo, Mexico.

1926. *Oedipus cephalicus* (*part.*) Dunn, the salamanders of the family Plethodontidae. Smith College publ. 1926, pp. 380-384 (MCZ Nos. 3912-3929).

Type. MCZ No. 3915, Guerrero, Hidalgo, Mexico; W. M. Mann, collector.

Paratypes. MCZ Nos. 3912-3914; 3916-3927. Michigan U. museum, Nos. 48061-48062, type locality, W. M. Mann, collector; EHT-HMS, Nos. 15656-15657, near Zacualtipan, Hidalgo.

Diagnosis. Belonging in the *cephalicus* group, with well-developed limbs and partially webbed feet. The first finger and toe slightly emergent from the "web"; outer toe extending distinctly beyond the "web"; limbs, when adpressed, separated by about two costal folds; dorsal surface of head with very fine pits; back smooth, the pits obsolete; about 38-44 teeth in the maxillary-premaxillary series of females; 33-35 males; 13-16 vomerine teeth, each series extending beyond nares and curving back to meet at a point medially one millimeter behind their anterior edges; snout moderate in females, sharply truncate with slight emargination, and two greatly-developed subnarial knoblike tubercles in males; head width in snout-to-vent length, 5½ to 6½ times; a groove from eye to gular fold; 12-(13) costal grooves. Black or brownish-black with silver spots or flecks, more prominent on sides and belly; throat black with silver or cream flecks.

Description of the type. Head moderately flattened; eye (3.05 mm.) much longer than length of snout (2.1 mm.), slightly longer than its distance from middle of the tip of snout. Width of an upper eyelid equal to the interorbital distance; distance between nostrils, 2.15 mm.; eyelids with their posterior parts fitting under a diagonal skin fold; very small pits indicated on the top of head, distinctly larger and closer together on eyelids and temporal region; maxillary-premaxillary tooth series, 44-44; 13-14 vomerine teeth, extending beyond the very minute choanae (.018 mm.), curving back and terminating slightly more than a millimeter back of their anterior border; the two vomerine series separated by a distance about equal to the diameter of the choanae; palatine teeth in two club-shaped series scarcely separated anteriorly, but distinctly diverging posteriorly, the total length, 4 mm.; width, 2.4 mm. posteriorly; separated from the vomerine series by a distance of one millimeter; mandibular teeth, about 40-40.

Body apparently somewhat compressed and slightly elevated along middle part of body; 12 costal folds not counting an inguinal fold, which apparently is obsolete or absent; skin on sides wrinkled slightly or minutely corrugated; on back smooth, on belly smooth with fine transverse lines, two or three to each fold; tail rather strongly constricted at base.

The vertical tail grooves are not strongly marked except on proximal portion; tail more or less wrinkled everywhere, somewhat compressed laterally; length of tail about one fifth less than head-body length; limbs moderately heavy, the first toe short, only the extreme tip extending beyond level of web; between the two middle fingers the web includes more than half of the proximal phalanges; fourth finger about one millimeter long; the web appears to continue along edge of digits as a fringe if the hand is slightly dried; fingers, 3, 2, 4, 1 in descending order of size; arm brought forward, the longest finger reaching posterior corner of eye; foot with a distinct web, including half the proximal phalanx of the second and third toes, all of the proximal phalanx of the fourth and fifth toes; first very slightly emergent from web; fifth toe extends beyond web one half millimeter or more; toes, 3, 4, 2, 5, 1 in descending order of size: ad-

Measurements in mm. and data from *Oedipus manni* sp. nov.

Number	3915	3920	3925	3916	3923	3912
Museum	MCZ	MCZ	MCZ	MCZ	MCZ	MCZ
Sex	♀	♀	♀	♂	♂	?
Snout to back end of anal slit	53.2	52	46	48	43	39.5
Length of snout	2.1	....	2.2	3	2.7	1.9
Head length to jaw angle	10	....	8.2	8.8	8.2	7.2
Head width	8.4	....	8	7.8	7.4	6.8
Eye	3.05	....	2.9	2.5	3	2.5
Axilla to groin	28	30	23.5	22	22	22
Arm	12.4	11.2–12	11	13	12	9.8
Leg	13.2	12.5–13	11.2	....	12.3	11.5
Tail	41	36	32	40.2	34	27.5
Costal grooves	12	13	12	13	12	12
Legs separated by folds	2	2½	2	touch	touch	2
Head width in head-body length	6.1	....	5.75	6.15	5.81	56.2
Maxillary-premaxillary teeth	44–44	40– ?	38	33–35	35–35	34–34
Vomerine teeth	13–14	13–13	13–13	?	15–16	15–14
Mandibular teeth	40–40	39–40	40–41	42–41	36–35	36–38

pressed limbs fail to meet by a distance equal to width of two folds; anal slit, 4 mm. long, the sides with diagonal folds; a strong gular fold across neck from which ascends a groove which cannot be traced to the dorsal surface; a groove crosses chin and reaches up beyond angle of mouth; a small glandular spot present behind insertion of femur.

Color (in alcohol). Dorsal surface grayish-brown (reddish-brown in life?), the head slightly darker; sides growing slightly darker towards venter; sides with a frosting of silver growing slightly more dense low on side; it is then replaced by scattered flecks and spots of cream or silver on ventral part of body and head; the chin region has the ground color darker and the silver spotting more dense than on abdomen; tail and limbs dark, flecked or spotted with silver; lower eyelid with some cream or yellow color.

Variation. In the paratype series, Nos. 3913, 3917, 3918, 3919, 3921, 3923, 3924, 3926, have been preserved in a different manner from the remainder of the MCZ specimens of the series. The ground color appears to be a deeper black and the frosting of the dorsal surface is obscured. The contrast of the black and silver on the belly is very pronounced. The specimens are somewhat shrivelled (as are specimens placed in too strong a solution of alcohol). The remainder of the series is well-preserved and the general appearance of the specimens (under water) is grayish on the sides and a dull black, grayish-black or grayish-brown along the back; the front borders of the eyelids and the tip of the snout are lighter, and the loreal region slightly darker than remainder of head; lips heavily flecked with whitish silver. The ventral ground color is a dull grayish black with the silver spots and flecks in strong contrast. Tail with silver flecks generally scattered or segregated, leaving large blackish spots (No. 3912) on tail.

The principal differences in the specimens are sexual, the males having a longer, very truncate snout, slightly emarginate when viewed in profile from above; the under side of the snout, which projects strongly beyond the mouth, is concave between the two greatly developed subnarial, knoblike bosses which project at the angles of the snout; the legs are a trifle longer and touch (at least in adult specimens) when adpressed.

A well-developed hedonic gland is present on chin of males. The eye is longer than the snout in females, nearly the same length or shorter in males; anal lips with papilla in male, and the premaxillary teeth (not more than four) pierce the lip. The reduction in

the number of teeth in the adult male is another sexual character. Older females seem to have a larger series of teeth than younger specimens.

Remarks. A male and female of this form (the latter the type) are described as *Oedipus cephalicus* by Dunn (*loc. cit.* 1926, pp. 381-382). The relationship of the species is with *cephalicus.* It differs strikingly in coloration and marking, the color of *cephalicus* being a dull blackish to bluish or grayish slate without distinct markings on body and tail; the tail of *O. cephalicus* is slenderer, less compressed, tapering more gradually and is distinctly longer; the axilla to groin measurement is longer and the limbs likewise longer than in specimens of *O. manni* of the same snout-to-vent length. The subnarial bosses are proportionally larger and the snout narrower and the pitting on head and body less conspicuous in *O. manni;* and the body is slightly compressed and deeper in the middle than in *O. cephalicus.*

The species is named for Dr. W. M. Mann, director of the National Zoölogical Gardens in Washington, the discoverer of the species. I am indebted to Dr. T. Barbour and Mr. A. Loveridge for the privilege of describing the species.

Oedipus orizabensis (Blatchley)

(Pl. XXV, figs. 1, 2)

1910. *Spelerpes orizabensis* Blatchley, Proc. U. S. Nat. Mus., 1893, p. 37 (type description; type locality, Mt. Orizaba, Veracruz, Mexico); Gadow, Proc. Zoöl. Soc. London, 1905, p. 203; Zoöl. Jahrb., 1910, pp. 709, 714.

1926. *Oedipus cephalicus* Dunn, The salamanders of the family Plethodontidae, Smith College Pub., 1926, pp. 380-384 (*part.*).

The species is represented in the collection by the following specimens EHT-HMS, Nos. 4000-4011, 4013-4023, 4025-4116, 4118-4123, 4125-4126, 4128, 4384 (Taylor-Smith), July 30-31, 1932, and 12188-12212, 12214-12216, 12281-12223, 12227, Aug. 12, 1936 (Taylor), between kilometers 58-66, west of Rio Frio, Puebla, elevation, 8,000 to 10,000 feet. No. 12225, near Las Vigas, Veracruz, elevation about 8,000 feet. Sept. 1, 1936 (Taylor). Nos. 4327-4367, 4378-4379, July 19, 1932 (Taylor and Smith), and 12044, 12045, 12048-12051, 12054, 12056-12058, 12062-12064, 12066, 12068, 12070, 12075, 12078-12080, 12083-12084, 12086, 12088, Sept. 2, 1936 (Taylor), Cruz Blanco and slopes of Cofre de Perote up to about 11,000 feet. Nos. 12099-12108, 12110-12113, 12115-12118, 12121-12122, 12232, 12235, 12236, 12241, 12244, 12247-12252, 12255-12257, 12259, 12263, 12265, 12266, Lake Zempoala, Morelos, 10,000 feet, Aug. 6, 7, 1936 (Taylor). Nos. 12267-12268, 12412, 12415, 12416, in a pedrigal, at kilometer 35

on road between Mexico City and Tres Cumbres, Morelos, July 8, 9, 1936 (Taylor and Smith).

Diagnosis. A grayish-black, medium-sized species with a tendency to grayish clouding on back; chin lighter; head flat; no canthus; palatine teeth in two slightly diverging series; separated from the vomerine teeth (rarely continuous); vomerine teeth, 12-17 in a curved series extending beyond choanae; adpressed limbs separated by from 1¾ to 4 costal folds; costal folds, 12-13; tail as long as head and body in adults; a small gland (appearing as a whitish spot) behind and slightly above the hind limb; head width in snout-to-vent length (above 50 mm.), about 7.5; head length in same, about 6 times. Hedonic gland on chin in males; the subnarial swelling much smaller than in *O. cephalicus* males, or *O. leprosus* males.

.*Description of the species.* (EHT-HMS No. 12049 ♀, slopes of Cofre de Perote near Cruz Blanca, Veracruz; Taylor-Smith, collectors.) Head rather flat in occipital and interorbital regions, rounding on snout; no canthus present; snout bluntly oval, the swellings below nostrils scarcely discernible; length of eye (2.5 mm.) greater than length of snout (2.1 mm.); upper eyelid (1.8 mm.) less than interorbital distance (2.3 mm.); distance between nostrils, 2 mm.; head width in snout-to-vent length, 7.2 times; head length in same, 6.4 times.

Thirteen costal folds, those in axilla and groin distinct; a discontinuous groove along middle of back not reached by the costal grooves; first gular groove crosses angle of jaw from about upper level of eye, and just fails to meet its fellow in middle of throat below; nuchal fold with irregular grooves arising from its ends which reach the median line forming an angle, pointing forward; a deep groove behind eye intersects the first gular groove and passes back, becoming continuous with the gular fold; costal grooves continued across belly; caudal grooves very distinct in adults; adpressed limbs fail to meet by a distance equal to about four costal folds; digits slightly webbed, the first very short with a free tip; the second is a trifle longer than fourth, the third longest; finger margined with a discernible fold of skin, and the ventral surface of the tip is padded; toes in the following ascending order of size: 1, 5, 2, 4, 3.

End of part of the hyoid apparatus causes a prominent, elongate raised area from gular fold, passing along the shoulder to a point some distance behind the arm; a glandular area behind and somewhat above the insertion of leg; skin of head thickly and regularly pitted as is the skin of dorsal and lateral parts of body; ventral surface with very minute pits.

Vomerine teeth in two series of 14-15, narrowly separated medially, curving, extending far beyond outer level of the choanae, separated from the palatine teeth by a distance equal to four or five times the diameter of the very small choanae; palatine series distinctly separated, diverging posteriorly the space between their posterior ends nearly double the width of one series; about forty maxillary teeth, those on premaxilla alternately large and small; 41-42 mandibular teeth.

Color. Generally grayish-black to slate, flecked or clouded above on body and tail with grayish-brown, and on sides with grayish-cream; below plumbeous, the throat and chin yellowish-white with scattered peppering of black; lower eyelid whitish; a cream mark on the tip of snout resembling an inverted U or V; gland behind and above insertion of hind leg grayish; underside of hands and feet dirty whitish; tiny arrow-shaped cream spots near the tips of the digits.

Table of measurements (in mm.) and data on *Oedipus orizabensis* Blatchley

Number	4000	12048	12049	12268	4379	12059	4024
Sex	♀	♀	♀	♀	♂	♂	♂
Snout to vent	55	57.5	51	56	53	52	45.4
Snout to foreleg	14.9	15.8	14	15	15	16	14
Axilla to groin	35.6	34.5	30	33.8	32 2	28	27.5
Head width	7.3	7.2	7	7 2	7	7	6.5
Head length	9.1	8.3	7.9	9.2	8.7	8.9	7.8
Tail	45	51	51	55	53.3	54	51
Arm	10.5	11.4	8.5	11.7	11.5	10.8	11
Leg	10.5	12	10	12	13.4	12.3	11
Vomerine teeth	17–17	13–14	14–15	15–17	12–13	13–13	13–13
Costal grooves	13	13	13	13	13	13	13
Head width in lgth. (times)	7.5	8	7.28	7.7	7.5	7.4	7
Head length in lgth. (times)	6.04	6.9	6.4	6.1	6.1	5.9	5.8

Variation. Some variation is observable in the number of vomerine teeth and the relation of the series to the palatine teeth. The maximum number of vomerine teeth observed was 17, and in this specimen, EHT-HMS 4000, the palatine and vomerine series were practically continuous. One other specimen had one or two teeth between the median ends of the vomerine series, making them practically continuous. The palatine series are about 5 millimeters

long. In EHT-HMS 4067 the series are together anteriorly and diverge posteriorly the width of one series.

Males have a well-developed hedonic gland on the tip of the chin; the premaxillary teeth (usually 2) pierce the lip, and occasionally are visible when the mouth is normally closed.

Specimens from Cruz Blanca and the slopes of Cofre de Perote often have brownish flecks and clouding on the dorsal surface of back and tail and the digits are a trifle larger, the hand and foot having a little more width; the light figure on the snout is distinct and in young the tip may be largely cream. The sides are often "frosted" with silver. Specimens from the region near Rio Frio, Puebla, have the dorsal surface of the tail with heavier clouding of cream and the snout marking is discernible only in younger specimens. Those from the Ajusco mountains (region of Tres Cumbres and Lake Zempoala) are more plumbeous, the light markings on the tail not so well pronounced; the dorsal and lateral silvery clouding is rather equally distributed.

The head width and length, in the snout-to-vent length, varies with the age and length. The head is contained a fewer number of times in younger specimens. The number of folds between the adpressed limbs is likewise variable with age. The axilla-to-groin measurement is greater in females containing eggs. Tails in younger specimens vary, being shorter than head and body. There is much variation in the thickness of the tails of preserved specimens. This is due to the amount of secretion from the tail.

Remarks. This species may be readily distinguished from *Oedipus cephalicus* by the larger feet and hands of that species, with their greater amount of webbing. Differentiation from *O. altamontanus* and *O. leprosus* is discussed under those species.

This seems to be one of the most common species in Mexico. The number of individuals taken is exceeded only by the smaller *O. chiropterus*. They are found together on the forest floor, under logs and debris.

I refer the following MCZ specimens to this species: Nos. 8404, 8417, 8418, 8420, 8421, 8423, 8426, 8427, 8431, all from Popocatepetl volcano, Mexico.

Oedipus cephalicus (Cope)

(Plate XXVI, figs. 3, 4)

1865. *Spelerpes cephalicus* Cope, Proc. Acad. Nat. Sci. Philadelphia, 1865, p. 196 (type description; type locality, "Mexican Tableland," Dr. C. Sartorius, coll.); and 1869, p. 106 (listed only "N. E. Mexico") Sumichrast, La Naturaleza, 1882, p. 79 (listed); Cope, Bull. U. S. Nat. Mus., No. 32, 1887, p. 8 (listed only); Boulenger, Cat. Batr. Grad. s. Caud. British Mus., 2d Ed. 1882, pp. 67-68 (redescription from Cope); Brocchi, Mission Scientifique

au Mexique et dans l'Amérique Centrale; Etude sur Batraciens, Livr. 3, 1883, p. 109 (by description from Cope); Cope, Bull. U. S. Nat. Mus., No. 34, 1889, p. 162 (key); Günther, Biologia Centrali-Americana, Rept. Batr., Dec., 1901, pp. 298, 229 (description after Cope); De Leon, Indice de las Batracios que se encuentra in la República Mexicana, 1904, p. 86 (list); Cope, Amer. Nat., Dec., 1896, p. 1022 (distribution).

1924. *Oedipus cephalicus* Dunn, Field Mus. Nat. Hist., XII, 1924, pp. 99-100 (key) (*part.*) and Salamanders of the family Plethodontidae, Smith Coll. Publ., 1926, pp. 380-384 (*part.*); and Proc. Acad. Nat. Sci. Philadelphia, 88, Oct. 20, 1936, p. 471 (Pablillo, Nuevo Leon); ? Wolterstorff, Abh. Ber. Mus. Nat. Heimatk. Natur. Ver, Magdeburg, Bd. VI, Heft. 2, 1930, p. 146.

Cope has said of this species: "The form of the present species is more that of *Ambystoma opacum*, and is the shortest and stoutest seen in the genus." The type has been lost and most of the specimens listed by Dunn (1926) as *O. cephalicus* apparently belong in other species.

The species is represented in our collection by a series of more than fifty specimens, with a range including Hidalgo, Central Veracruz, Morelos, and Puebla, as follows:

EHT-HMS. Nos. 4117, 4313-4326, Cruz Blanca, Veracruz north side of Cofre de Perote, 8,000 feet, July 13, 1932, Taylor and Smith; 4368-4370 near Tres Cumbres, Morelos (km. 35 on highway) July 11, 1932, Taylor and Smith; 4371-4375 Cruz Blanca, Veracruz, July 18, 1932, Taylor and Smith; 4534-4540, between Rio Frio and Puebla, Puebla, July, 1932, Taylor and Smith; 4012, Rio Frio, Puebla, July, 1932, Taylor; 12092-12095, 12098, 12097, 12260, 12493, Lake Zempoala, near Tres Cumbres, Morelos, 8,500 to 10,000 feet, Sept. 4-6, 1936, Taylor; 12269-12270, 12413, km. 58, near Tres Cumbres, Morelos, July 10, 1936, Smith and Taylor; 12495, near Minas Viejas, 7,000 feet, near Jacala, Hidalgo, on highway, July 5, 1936, Taylor; 12042, 12052, 12059, 12065, 12067, 12073, 12077, 12081, 12123, 12089, 12224, above Cruz Blanca on north side of Cofre de Perote, Veracruz, in pines, elevation 8,000-10,500 feet, Sept. 2, 1936, Taylor.

Cope's description contains the following data: "Muzzle rounded, truncate, with obtuse angles at the nares, its length from line connecting anterior canthus oculorum equal length of eye. Distance between these canthus equal from hinder canthus to nares. Breadth behind orbits equal length of tibia and foot. Muzzle to axilla equals ⅔ distance from axilla to groin. Costal folds (*i. e.*, dorsal and lumbar vertebrae), eleven. Tail swollen, little compressed, constricted at base. Posterior limb stout, extending to sixth fold from behind; toes flat, depressed, margined, inner very rudimental. Inner and outer digits of anterior limb similar; the longest extend to near the middle of orbit. Series of vomerine teeth nearly straight, not in contact; a postgular fold. Skin everywhere finely wrinkled. Color dull black, paler on the sides, lips and gular region minutely marbled with ashen. *Length of rictus oris, 2.75 lines [6.3 mm.];

* I am designating EHT-HMS 4372 as a neotype, since (*fide* Dunn 1926) the type is lost. The designated specimen is practically the same size as the type. The measurements corresponding to the above are, respectively, 6.2 mm.; 15 mm.; 37 mm.; 38.8 mm.; 11.3 mm.

length to axilla, 6.8 lines [15.6 mm.]; length to groin, 16 lines [36.8 mm.]; length of tail, 15 lines [34.5 mm.]; length of hind limb, 5.2 lines [11.9 mm.].

Description of species. (From EHT-HMS No. 12098 ♀, collected Lake Zempoala, Morelos, Aug. 5, 1936, E. H. Taylor, collector.) Head flat, the canthus well defined in front of eye, but becoming rounded and disappearing near nostril; snout sharply truncate, extending a very short distance beyond mouth; tubercular swellings below nostril near lip; length of eye slightly longer than snout; interorbital distance one and one half times the width of eyelid; distance between nostrils about equal to greatest width of an eyelid; posterior edges of upper and lower eyelids pass under a diagonal fold; posterior line of mouth turns up at rictus; first nuchal groove begins on sides of head, passes down and completely across throat; a strong nuchal fold, the grooves from the two sides continuing up on dorsal surface, where they meet at an angle, directed forward; 12 costal grooves, the axillary and inguinal rather dim; skin between folds forming numerous longitudinal wrinkles (tail somewhat shrivelled due to excessive secretion of mucous; in life tail rather plump); tail distinctly constricted at base; the vertical grooves very indistinct on tail; costal grooves discernible across belly; skin on dorsal and lateral surfaces and on breast strongly pitted.

Limbs well developed, the anterior brought forward, the finger reaches to near middle of eye; adpressed limbs separated by less than two folds (about 1½ to 1⅔ folds); fingers and toes partially webbed, this webbing much thickened, the digits themselves flattened and more or less definitely margined; first finger much smaller and shorter than fourth; ascending order of length of fingers, 1, 4, 2, 3; of toes, 1, 5, 2, 4, 3; walls of cloaca heavily folded at anal opening; head width in length (snout-to-vent), 5.9 times; length of head, in same, 5.3 times.

Vomerine teeth in two nearly straight series of 15-18, which become slightly curved medially, not meeting on median line, the teeth somewhat irregular; palatine series about 5 mm. long (abnormally short on right side), the groups not tending to diverge posteriorly; separated from the vomerine teeth by a distance equal to four times the diameter of the very small choanae; vomerine teeth extend much beyond the outer edges of choanae; maxillary premaxillary series, 39 on each side; 42-45 mandibular teeth.

Color. Blackish or grayish-black above and below, with some lighter flecks on chin, the flecks less noticeable on abdomen; the un-

derside of tail flecked and clouded with lighter color; upper side of tail with occasional, very indistinct brownish flecks.

Measurements of *Oedipus cephalicus* Cope

Number	12098	4368	12242	4369	4372*
Sex	♀	♂	♀	♂	♀
Snout to vent	53	52.2	57	60.2	40
Tail	50	52	50	55.5	33.8
Snout to arm	16.5	16	16.5	18	13.5
Axilla to groin	33.1	29.5	35.2	35.2	23
Width of head	9	8.5	9	9.2	7.4
Length of head	10	10	10	11	7.1
Eye	3	3	3.5	3.4	2.1
Eyelid	2.7	2.7	2.7	2.3	2
Snout	2.9	3.5	2.8	3.2	2.2
Interorbital width	3.1	3.1	3	3.2	2.2
Arm	13.1	15.5	15	15.3	10.9
Leg	16	16.2	16.1	18	11.5

* 4372 is designated the neotype.

Variation. The table shows variation in measurement. The tail is proportionally shorter in younger specimens. Males differ in having 33-34 maxillary teeth, with three or four premaxillary teeth piercing the lip; 39-42 mandibular teeth; snout longer than eye; the swellings below nostril are greatly inflated, and the snout projects more beyond mouth; adpressed limbs touch or are more narrowly separated than in females; males have a flat gland near tip of chin, and the webbing of the toes is somewhat greater. The smallest specimen, 18 millimeters, snout-to-vent, has the head greatly roughened, as do others up to 25 millimeters length.

Remarks. The specimens were found under logs, usually not directly on the earth but on grass or other trash. When captured, they exuded much mucous secretion, and again this was done when they were placed in alcohol for killing. The result is that the tails of all the specimens look shrivelled. The silvery flecks on the ventral surface are occasionally distinct in life, giving the belly a frosty appearance; this disappears in preserved specimens.

From the various localities there were observable some slight differences in the webbing of the digits and the spread of hand and foot. When males and females of equal length are compared the male usually has slightly larger feet and hands.

I have examined certain salamanders in the United States National Museum and specimens from the Museum of Comparative Zoölogy, Harvard College. I am referring the following specimens to this species: MCZ Nos. 8408, 8419, 8424, 8428-8430. 9,000 feet Popocatepetl, Pue., MCZ 8376, Jalapa.

Oedipus robertsi sp. nov.

(Plate XXVI, fig. 2)

Holotype. EHT-HMS, No. 12503, collected Nevada de Toluca, elevation between 10,000 and 11,000 feet, Sept. 7, 1936; H. Radclyffe Roberts, collector.

Paratypes. EHT-HMS, Nos. 12496-12498, 12504-12505, collected same date and locality by Philip Powers, Edwin R. Helwig, Radclyffe Roberts and Edward H. Taylor; Nos. 15600-15615, topotypes, Taylor.

Diagnosis. A medium-sized species related to *O. orizabensis* and *O. leprosus*, but differing in having a somewhat more robust body, with a broad, orange stripe on the back and tail, much larger limbs and toes, the latter lacking any trace of a web; adpressed limbs in contact or separated by a part of one costal fold; tail shorter than or almost equal to head and body length; vomerine teeth, 8 or 9 in a curved series; 13 costal grooves (counting one in axilla which is very indistinct); head length in head body length, 5.7 times; head width in same, 6.2 times.

Description of type. Head broad, rather flattened; no trace of canthus; snout truncate, the nostrils very close to anterior point; snout extending beyond mouth .5 to .7 millimeters; a rounded swelling below nostril near lip; interorbital width equals distance between nostrils, a little greater than width of an eyelid; length of eye about one fifth longer than snout; upper surface of head, between eyes and on the region behind eyes, flat; occipital region not, or but slightly, swollen; a strong nuchal fold across the ventral surface of the neck; a groove from this to dorsal surface, where it runs forward somewhat, joining the groove from the opposite side; a short, vertical groove on side of head crosses angle of jaw somewhat back of the angle of the mouth and continues on the side of head to dorsal surface; a groove from behind eye crosses this groove and continues back to the nuchal groove, where it terminates; 13 costal grooves, that in axilla very dim; area between grooves very wrinkled, the upper edge of the wrinkled area suggestive of discontinuous sinuous, longitudinal groove; tail constricted at base,

the folds between the caudal grooves wrinkled; tail compressed laterally; length of head in snout-to-vent length, 6.2 times; outline of edge of upper jaw almost straight; posterior ends of both eyelids fitting under a fold of skin.

Limbs well developed, when adpressed, the digits separated by a distance of one costal fold or less; no trace of webs; digits flattened, save at tip, which is definitely inflated and rounded; first finger very short, its tip free; ascending order of length of fingers, 1, 4, 2, 3; of toes, 1, 5, 2, 4, 3; skin on dorsal surface of head and body more or less minutely pitted; tail a little shorter than head and body.

Vomerine teeth in two slightly curved series of 8 or 9 teeth, extending beyond the outer edges of choanae, separated from each other by a distance one and one half times the width of a choana; palatine teeth in two series, very narrowly separated anteriorly, and diverging somewhat posteriorly; 19-20 maxillary teeth; 4 or 6 premaxillary teeth.

Color. Above a broad, variegated, orange-reddish stripe from head to tip of tail; sides somewhat brownish lavender; below lead color (specimen is now somewhat discolored and is quite deep brown on sides and abdomen), a few spots of orange-brown on head and along sides. Underside of hands and feet immaculate.

Measurements of *Oedipus robertsi* sp. nov.

Number	12503	12497	12504	12505	12498	12496
Sex	♀	♂	♀	♀	♀	♀
Snout to vent	51	48.8	47.4	36.5	38.1	34.5
Head length	8.2	9.4	9.2	7.5	7.6	7.2
Head width	8.9	7.8	7*	6	6.5	6
Snout to arm	17.2	15	15	11.4	12.9	10.5
Axilla to groin	30	29.2	26.3	22.2	22.6	20.3
Interorbital width	2.9	2.6	2.9	2	2.2	2
Eyelid	2.3	2	2.1	1.8	1.5	1.5
Eye length	3	3	2.5	2.5	2.5	2.1
Snout	2.3	2.4	2.6	2	2	1.9
Tail	44.8	48.5	47	33	33.5	30

* Injured.

Variation. In most of the characteristics the paratypes agree with the type. In the younger specimens the digits touch when adpressed and the tail may equal the length of head and body. The dorsal stripe may break up into spots on the tail. A male (No. 12497)

differs in having a larger swelling below the nostrils, the snout slightly more truncate, and a well-defined gland on chin near tip of the lower jaw; the premaxillary teeth (4) pierce the upper lip and the anal slit has the wall papillate instead of folded as in the female. The stripe may be brown or faun.

Remarks. The specimens were found at an elevation between 10,000 and 11,000 feet, along the road leading to the summit of the volcano, Nevada de Toluca. They were found for the most part under stones, in the pine forest.

The species is dedicated to Mr. Radclyffe Roberts, of the Philadelphia Academy of Sciences, who assisted in collecting the types and made possible the journey to the mountain.

Oedipus multidentata sp. nov.

Oedipus chiropterus Dunn, Acad Nat Sci Philadelphia, 88, 1936, p. 471

Type. MCZ, No. 14812, ♂; Alvarez (km. 53 on Potosi y Rio Verde R. R.), San Luis Potosí, Mexico, elevation 8,000 feet, W. W. Brown, collector.

Paratypes. MCZ, Nos. 14810-14811. Topotypes. Brown, collector. UMMZ, Nos. 63946, 63948, 63953; EHT-HMS, 15658-15848, El Chico, Hidalgo.

Diagnosis. A small species related to *Oedipus chiropterus*, but differing in having longer and larger limbs and feet which touch or overlap when adpressed, tail somewhat more attenuated; eye somewhat larger, and head slightly more flattened; adult males with the maxillary-premaxillary tooth series 20-24 in each half of jaw (in *O. chiropterus* usually 6-6), and the teeth appear to be stouter than the teeth in the females of *chiropterus*. The vomerine series assume a more transverse position, and the choanae are somewhat larger.

Description of the type. Head rather flattened; eye (2.5 mm.) slightly shorter than snout (2.7 mm.); distance between nostrils, 2.15 mm.; smallest interorbital width (2.1 mm.) is greater than width of an upper eyelid (1.7 mm.); width of head (6.2 mm.) contained in distance between snout and posterior end of vent (39.5 mm.) 6.37 times; head length (8.5 mm.) in same distance, 4.64 times; line of mouth diagonal and somewhat undulant posteriorly; subnarial swellings prominent, giving the snout a slightly angulate appearance; snout truncate with a faintly indicated canthus, below which is a very slight depression extending from eye toward nostril; hedonic gland on chin indistinct. Vomerine teeth, 7-8, extending near to outer edge of choanae, nearly transverse, but forming an

angle posteriorly, the series separated by a distance a little less than diameter of a choana; parasphenoid teeth in two distinct series, widening posteriorly and diverging slightly posteriorly, separated from the vomerine series by a distance equal to two thirds the distance between choanae; maxillary teeth extending back past the middle of the eye; premaxillary teeth somewhat more elongate and slenderer, none piercing the lip but extending outside the lower lip, the combined maxillary-premaxillary series 24-24; mandibular teeth large, 24-26, fitting distinctly within the upper series.

Skin of head rather heavily pitted (in the type the epidermis has been recently shed and this character is not obvious); a strong nuchal fold curves across throat and from its edges arise grooves which ascend the side of neck; on the occiput the musculature causes ridges and grooves in the skin; two prominent ridges converge on the back part of head with a distinct median groove between them which continues along the dorsal surface of the body and tail; two grooves pass back irregularly to join the nuchal groove; these are traversed by a groove which crosses throat and passes upwards behind, or across, angle of mouth; eleven costal grooves, the axillary and inguinal grooves not indicated (somewhat apparent in a paratype).

Skin of the dorsum not strongly pitted; on the tail, the pits are similar to those on the head; tail very slightly constricted at base; about seven or eight vertical grooves indicated, these near the base; tail 52 mm. long, more than a fourth longer than head and body.

Fingers, 1, 2, 4, 3, in ascending order of size, the inner greatly reduced and wholly included in web; web includes most of the proximal phalanx of the second and fourth and extends to and includes a part of the second phalanx on the third digit; terminal part of digit very slightly spatulate; toes, 1, 5, 2, 4, 3, in ascending order of size, the first included in web; web includes all of the proximal phalanx and part of adjoining phalanx of the four outer digits; pads under tips of digits prominent; limbs when adpressed overlap the width of one fold; a small glandular spot behind insertion of femur.

Color in alcohol. Above, nearly uniform brown save that the lower eyelid is yellowish or cream and a minute touch of lighter color present at tip of snout and on the subnarial swellings; below, brownish, of a very much lighter shade; chin and under hands and feet brownish white.

Measurements, in millimeters, and data on Oedipus multidentata. Type and paratypes. MCZ Nos. 14812, 14811, 14810, respectively.

Sex ♂, ♂, yg.; snout to vent, 39.5, 31.5, 24.1; length of snout, 2.7, 2.3, 1.7; snout to arm, 13, 10, 1.5; axilla to groin, 20.4, 15.2, 13.5; tail, 52, 40, 29; head width, 6.2, 5.2, 4.4; head length to jaw angle, 8.5, 7, 5; forearm, 10, 10, 7; leg, 12.1, 10, 7.1; head width into head-body length, 6.37, 6, 5.4 times; head length into head-body length, 4.6, 4.5, 4.8 times; maxillary-premaxillary teeth, 24-24, 21-21, 23-23; vomerine, 7-8, 6-5, 6-6; mandibular series, 24-24, ——, 23-22.

Variation. Practically no variation is evident save that recorded above. The amount of overlapping in adpressed limbs is less in smaller specimens.

Remarks. As stated, this species is most closely related to *Oedipus chiropterus*, and resembles the latter rather strongly. The large number of teeth, typical of the females of *chiropterus*, are present here in the males. The males of *chiropterus*, in the adult condition, have no posterior maxillary teeth, and those that are present anteriorly are larger than the teeth in the female. The sexual dimorphism in *chiropterus* is striking as regards dentition.

Oedipus chiropterus (Cope)

1863 *Spelerpes chiropterus* Cope, Proc. Acad. Nat. Sci. Philadelphia, 1863, p. 195; (type description; type locality, Mirador, Veracruz, Mexico. Dr. Sartorius, collector); and, 1869, p. 106; Boulenger, Cat. Batr. Grad. s. Ecaud. British Mus., 2d Ed., p. 67; Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale, Etude sur Batraciens, Livr. 3, 1883, p. 109; Cope, Bull. U. S. Nat Mus., No. 32, 1887, p. 8; and No. 34, 1889, p. 162; Dugès, La Naturaleza, 1896, (2), 2, p. 482; Gunther, Biologia Centrali-Americana, Rept. and Batr. 1902, p. 298; Gadow, Proc. Zool. Soc. London, 1905, p. 203, and Zool. Jahrb., 1910, p. 714.

1865. *Spelerpes orculus* Cope, Proc. Acad. Nat. Sci. Philadelphia, 1865, p. 196 (type description; type locality, Mexican tableland and southern mountains); Herrera, La Naturaleza (2), 1, p 340; and 1892, p. 49.

1924. *Oedipus chiropterus* Dunn, Field Mus. Nat. Hist., Zool. Ser., XII, 1924, pp. 99-100; Salamanders of the Plethodontidae, Smith College 50th Anv. Publ., 1926, pp. 354, 368-371 (*part.* not MCZ Nos. 8404, 8408).

This small species appears to be widely distributed at high elevations in Central Mexico; in these localities it is the most common species.

The following specimens of *O. chiropterus* are in the collection: EHT-HMS Nos. 4129-4156, 4158-95; 4197-4232, 4381-4383, 4385-4388, 4390-4404, 4406-4430, 4432-4446, 4448-4454, July 30, 31, 1932, and 4460-4499, July 11, 1932, from near Rio Frio, Puebla, elevation 9,000 to 10,000 feet; Taylor and Smith.

Nos. 12144-12165, 12167-12177, 12179-12185, Aug. 12 at km. 58, near Rio Frio, Puebla, elevation about 10,000 feet; Taylor.

Nos. 4233-4312, 4500-4503, July 18, 1932, Taylor and Smith, and Nos. 12000-12006, 12008-12029, 12031-12039, 12041-12047, 12053,

12060, 12061, 12071, 12076, 12082, 12087, Sept. 2, Taylor, Cruz Blanca and slopes of Cofre de Perote up to 11,000 feet, Veracruz.

Nos. 3971-3972, Sept. 15, 1935, Taylor; No. 4380, July 11, 1932, Taylor and Smith, and Nos. 4512-4514, 4516-4517, 4521-4532, Taylor, km. 50 near Tres Cumbres, Morelos; Nos. 12271-12291, 12293-12329, 12331-12333, 12335-12411, 12417-12419 km. 35 near Tres Cumbres, in a pedrigal, July 6, 1936, Taylor and Smith.

Nos. 12124-12140, 12233, 12234, 12237, 12240, 12243, 12246, 12253, 12254, 12261, 12262, 12264, 12420-12428, 12430-12432, 12434-12437, 12440-12488, 12490-12492, Lake Zempoala, Morelos, elevation 10,000 to 11,000 feet, Aug. 5, 6, 1936, Taylor.

Diagnosis. A small species with the feet and hands partially webbed; first finger and first toe short, completely involved in the web; 13 costal grooves; vomerine teeth in two very short series of six or seven teeth tending to meet at an oblique angle, the series separated by a distance equal to the normal space between two teeth; extending to inner level of choanae; females with a maxillary-premaxillary series of 20-24 teeth, the series beginning about middle of eye; adult males with about six or seven teeth in the series beginning much in advance of the eye, the teeth much enlarged; the four premaxillary teeth much enlarged, but while visible externally do not, or only occasionally, pierce the lip; no canthus rostralis; large, plainly visible hedonic gland on tip of chin in male, and a small gland behind and slightly above insertion of hind limb; a continuous median dorsal groove not reached by the lateral grooves. Tail longer than snout-to-vent length. Color variable; dull grey or bluish black on entire dorsal and lateral surfaces, with ventral surfaces lighter; or dorsal surface creamy-vinaceous, with sides blackish. Sometimes the lighter cream color forms two dorsolateral lines, the vinaceous a median stripe; others are uniformly lighter, nearly lavender above with lighter shades below. One specimen is cream with the pigment segregated to form irregular spots above and below.

Variation. The vinaceous pattern at times is so constant that one feels that one is dealing with a distinct race; yet this same variation crops up with greater or lesser degree of frequency throughout the range. The limbs when adpressed are separated by from four and one half costal folds to two costal folds. The higher number usually applies to females, while in typical males the limbs are separated by two to two and one half folds.

Remarks. The species is known from the states of Veracruz,

Puebla, México, Morelos and Distrito Federal. I failed to obtain specimens of the species on Nevada de Toluca at elevations where one would normally expect them to be plentiful.

Cope's *Spelerpes orculus* from the Mexican Tableland seems to be properly associated with this species as a synonym.

Oedipus pennatulus (Cope)

1869. ***Thorius pennatribus*** (typ. err.) Amer. Nat., 1869 p. 222

1869. ***Thorius pennatulus*** Cope, Proc. Acad Nat Sci Philadelphia, 1869, pp. 111-112; (type description; type locality, "Orizava," Mexico, F. Sumichrast, collector; type USNM. No 6341 originally); Boulenger, Cat. Batr. Grad. British Mus (2), 1882, p. 79, pl 3. fig 2 (head and neck) (Orizaba, Mexico); Cope, Bull. U S. Nat. Mus., 34, pl. 27, figs. 2-4 (Skull, *fide*, Dunn 1926); Gunther, Biologia Centrali-Americana, Rept. Batr., 1902, pp 304-305; Gadow, Proc. Zool. Soc. London, 1905, p. 202

1883. ***Thoruis (sic) pennatulus*** Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale, part 3, sec. 2, Etude des Batraciens, Livr 3, 1883, p. 119.

1922. ***Oedipus pennatulus*** Dunn, Proc. Biol Soc Washington, 35, Mar. 20, 1922, p. 6; and Field Mus. Nat. Hist, Zool Ser. XII, May 19, 1924, pp. 99, 100 (key); and The Salamanders of the Family Plethodontidae, Smith College Fiftieth Anniversary Publications, 1926, pp. 469, 374-376, fig. 64, map.

?1877. ***Spelerpes*** sp. Wiedersheim, Morph Jahrb. 3, 1877, pp. 427, 482, 498, pl 21, fig 48, pl 24, fig. 87 (Veracruz; Dunn suggests that this should be in this synonymy. If so it is likely the locality refers to the state, not the city).

?1877. ***Spelerpes minimus*** Wiedersheim *loc cit* p. 544 (Veracruz)

Description of species. (From EHT, Nos. 12141-12143, 12343A, 12343B; collected near Acultzingo, Veracruz, Aug. 14, 1936, by E. H. Taylor.) Very small species; body moderately slender, the tail about one and one third times as long as head and body; snout blunt, somewhat oval, seen from above, the eyes extending beyond outline of head; no canthus rostralis, and no longitudinal groove behind eye; first vertical groove close behind angle of mouth; eye large, its length greater than length of snout; both eyelids fitting under the fold of skin behind eye; nostril very large, its diameter more than one third of eye; edge of lip slightly swollen at the groove; angle of the jaw a little behind the angle of the eye; width of head contained in head-body length, 7.3 times; head length in head-body length, 5.6 times; 13 costal grooves from axilla to groin; the foreleg covers three costal folds, the hind leg four; when limbs are adpressed, separated by 6 folds; limbs weak, fingers 3, 2, 4, 1 in descending order of length; one and four are not free at tip; toes 3, 4, 2, 5, 1 in descending order of length, the two outer toes rudimentary, not free at their tips; anal lips slightly rough; vomerine teeth in short series *not* extending beyond nares; three to five teeth in series; no teeth on maxilla; parasphenoid teeth in a single, rather broad patch; three teeth on the premaxilla.

Color. Above brown, color only slightly lighter than the dark lateral bands which merge imperceptibly into the ventral colora-

tion (under magnification the ventral coloration consists of closely-set circular, cream dots separated by black reticulation); a few lighter flecks on ventral surface of belly and chin.

Variation. The dorsal lighter band is evident on all the specimens and the light flecking is present on ventral surfaces and sides; the head is the color of the sides; one specimen has a suggestion of a dim row of darker flecks on the dorsal median line.

Measurements and data on *Oedipus pennatulus* Cope

Number	12141	12142	12143	2245	2244
Snout to vent	25.2	18.4	21.2	20.2	21.2
Snout to gular fold, below	4.5	3.6	4	3.8	4
Snout to foreleg	7.1	5.2	6.1	6.1	6.5
Tail	33 2	19*	28	25	22.5*
Width of head	3.45	2.8	3.5	3.8	3.5
Arm	3.4	3.2	3.5	3.8	3 5
Leg	4	3.3	4	4 1	4.1
Axilla to groin	15.4	10.8	12	12.3	13 5
Costal grooves	13	13	13	13	13
Grooves on tail	40	28*	39	32+	22+

* Not complete.

Remarks. These small specimens were taken under rocks at the top of a mountain south of Acultzingo (where the highway crosses). When found they were closely coiled in a watch-spring spiral, and remained so coiled until about five seconds after being placed in alcohol.

Oedipus lineolus (Cope)

(Pl. XXIX, fig. 3)

1865. *Spelerpes lineolus* Cope, Proc. Acad. Nat. Sci. Philadelphia, 1865, p. 197 (type locality, Mexican tableland; C. Sartorius, collector); idem, 1866, p. 132 (Orizaba, Veracruz); idem. 1868, p. 313 (Córdova, Veracruz); Boulenger, Cat. Batr. Grad. British Mus., (2) 1882, p. 74 (Orizaba, "Mexico"); Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale, Etude des Batraciens, part 3, sec. 2, livr. 3, 1883, p. 111; "Orizava" Veracruz, Günther, Biologia Centrali-Americana, Batrachia, Jan., 1902, p. 304 (Orizaba).

1869. *Ophecoatrachus lineolus* Cope, Proc. Acad. Nat. Sci. Philadelphia, 1869, pp. 101-102 (Eastern Mexico).

1884. *Geotriton lineolus* Garman, Bull. Essex Inst. 16, 1884, p. 39.

1887. *Oedipina lineolus* Cope, Bull. U. S. Nat. Mus., 32, 1887, p. 8.

1896. *Oedipina lineola* Cope, Amer. Nat., 1896, p. 1022 (distribution).

1924. *Oedipus lineolus* Dunn, Field Mus., Nat. Hist. Zoöl. Ser., XII, No. 7, Publ. 221, May 19, 1924, pp. 99, 100; and The Salamanders of the Family Plethodontidae, Smith College Ann. Ser., 1926, pp. 422-425, map, fig. 81 (Mexican tableland; Jalapa, Veracruz).

?1879. *Spelerpes (Oedipus) infuscatus* Peters, Monatsb. Konigl. preuss. Akad. Wiss. Berlin, 1879, p. 778 ("Hayti." Seems probable that this locality is erroneous).

?1902. *Spelerpes uniformis (part.)* Günther, Bioligia Centrali-Americana, 1902, p. 304.

Description of the species. From EHT-HMS, No. 2415; collected about 10 km. southeast of Cordova, near San Lorenzo, Veracruz, Aug. 20, 1937.

Body slender, cylindrical, wormlike; the tail elongated, nearly as thick as body, tapering rather suddenly near the tip; snout blunt, truncate, the eyes protruding beyond outline of head when seen from above; no canthus rostralis; no longitudinal groove behind eye; vertical groove a little behind angle of mouth; visible below, and arising to upper level of eye; angle of jaw is much behind posterior angle of eye; both eyelids fit under a fold of skin posteriorly; second groove, forming a nuchal fold below, and practically encircling neck; eye distinctly longer than the snout; nostrils small; no swollen area about the narial groove; 14 costal grooves, counting the dim ones in axilla and groin; about 43 grooves on tail. Limbs very slender, short, the anterior reaching to about the third costal groove, the hind leg reaching to very near 12th groove, leaving the adpressed limbs separated by 9 complete costal folds; fingers very minute, their descending order of size, 3, 2, 4, 1, the tip of the first involved in skin, others free; order of length in toes, 3, 2, 4, 5, 1, the tip of first toe not free; anal lips apparently smooth.

Vomerine teeth, in two curved series, consisting of 10 and 13 teeth, meeting medially; parasphenoid teeth in two groups, confluent anteriorly, divergent posteriorly, separated from the vomerine teeth by an interval more than half distance between the choanae; maxillary and premaxillary with teeth.

Color. Above dark, nearly black; below grayish-black (under magnification the ventral coloration consists of minute round cream dots of various sizes, separated by black). A few scattered cream flecks on the chin, throat and side of head, especially below eye.

Measurements (in mm.). Snout to vent, 34.5; snout to arm, 9.4; width of head, 3; axilla to groin, 21.2; tail, 51.5; total length, 86; head width, in snout-to-vent length, 11 times. (I suspect that the tail has been reproduced.)

Remarks. I found this specimen on the side of a rocky hill southeast of Cordova. The specimen was hidden in a pile of wet chips about the base of a stump.

The species has remained very rare in collections. Dunn (1926) was able to examine but three specimens. From the measurements recorded, either the species is variable or the differences in proportion are due to age and sex. Dunn (1926) has referred the Haitian, "*infuscatus*" of Peters, to this form.

Oedipus salvinii Gray

(Plate XXVIII, fig. 2)

1868. *Oedipus salvinii* Gray, Ann. Mag. Nat. Hist. (4), 2, p. 297 (type description: type locality, Guatemala, Pacific Coast; O. Salvin, collector); Sumichrast, Bull. Soc. Zool. France, 5, 1880, p. 190; and La Naturaleza, 6, 1882, p. 79; Dunn, Field Mus. Nat. Hist. Zoöl. Ser., XII, May, 1924, pp. 99, 100 (key); The Salamanders of the Family Plethodontidae, Smith College Fiftieth Anniversary Publications, 1926, pp. 405-408, fig. 74, map. Schmidt, Field Mus. Nat. Hist., Zool. Ser., XX, No. 17, Oct. 31, 1936, pp. 147-148, fig. 17

1879. *Oedipus carbonarius salvinii* Cope, Proc. Amer. Philos. Soc., 18, 1879, p. 267.

1882. *Sperlerpes variegatus* Boulenger, Cat. Batr. Grad. s. Caud. British Mus., 2d ed., 1882, p. 73 (*part.*).

1887. *Oedipus variegatus salvinii* Cope, Bull. U. S. Nat. Mus., No. 32, 1887, p. 8.

1878. *Spelerpes salvinii* Müller, Verh. Naturf. Ges. Basel, 6, 1878, p. 579 ("Guatemala"); Strauch, Salamanders, p. 84 (not seen); Brocchi, Mission Scientifique au Mexique et dans L'Amérique Centrale, Etude sur Batr., livr. 3, 1883, p 117, pl. 18, figs. 3, 3a, 3b, 4, 4a, 46. (Tehuántepec); De Leon, Indice de los Batracios que se encuentran en la República Mexicana. Tacabuya, June, 1904, p. 38.

1896. *Spelerpes variegatus* Werner, Verh. Ges. Wien, 46, p. 351; Gunther, Biologia Centrali-Americana. Rept. and Batr., Jan., 1902. p. 302 (*part.*), pl. 75, fig. D.

1878. *Spelerpes* sp affin. *sp. salvinii* Müller, Verh. Naturf. Ges. Basel, 6, 1878, pp. 579, 645, pl. III, figs. C. C., D (Guatemala).

Description of species. (From EHT-HMS, No. 3995, ♀; collected at Tonolá, Aug. 27-31, 1935.) (Taken in a freight car on railway.) Body, typical salamander form. Head flattened, the outline a truncate oval, distinctly wider than body; eye relatively small, its length not as long as snout, but about equal to its distance from the nostril; the hind part of eyelids inserted under a fold of skin; nostrils small; a swelling below nostril about groove on upper lip; the angle of the jaw extends far behind the posterior corner of eye. An ill-defined shallow groove from eye to first vertical groove. A strongly-defined gular fold which reaches up only a short distance on the sides of neck; vomerine teeth in two curved series, practically meeting medially, and extending laterally beyond the choanae; about 15-17 teeth in a series; parasphenoid teeth in a large patch pointed anteriorly, posteriorly with a median notch, separated from the vomerine teeth by twice width of a choana; maxillary tooth series large, extending back to the middle of the eye socket; thirteen costal grooves; the adpressed limbs separated by three and one half folds; limbs strong, the arm reaching eye; fingers fully webbed, flattened; the front outline of hand scalloped; toes completely webbed, flattened. Tail slightly longer than head and body, distinctly constricted at base; anal lips smooth or slightly folded.

Color. Above deep purplish lavender broken into irregular areas and surrounded by cream borders; beginning on snout an irregular, yellow, more or less discontinuous line extends dorsolaterally; beginning behind the eye is a broad chocolate band, very irregular on its upper edge, and fairly straight on lower edge (somewhat laven-

der on the upper edge). Lips and ventral surface of head and body cream-yellow with a few flecks of darker color; under tail same, but flecked more heavily with lavender; tail dark purplish lavender, reticulated on at least proximal half with cream.

Measurements (in mm.). Snout to vent, 81; snout to jaw angle, 10.2; snout to gular fold (ventral), 19; snout to insertion of arm, 24; width of head, 12; tail, 86; arm, 18; leg, 19; axilla to groin, 50; width of head in snout-to-vent measurement, 6.75 times; head length into snout-to-vent measurement, 4.26.

Remarks. Since this specimen was taken in a freight car used for transporting bananas, its provenance is uncertain; however, it seems very probable that it originated on the coast, most probably in southern or central Chiapas.

Oedipus platydactylus (Cuvier)

(Plate XXVIII, fig. 1)

1831 *Salamandra variegata* Gray, in Griffiths Cuvier's Animal Kingdom, 9, p 107 (not of Bory St. Vincent, 1829, Dict Class Hist Nat., 15, p 68) (type description; type locality, Mexico).

1831 *Salamandra platydactylus* Cuvier, in Gray, Griffith's Cuvier's Animal Kingdom, p. 107.

1838. *Oedipus platydactylus* Tschudi, Mem Soc Sci. Nat Neuchâtel, 1838, p 58; Dunn, Field. Mus Nat Hist. Zool Ser , XII, May, 1924, pp. 99, 100; and The Salamanders of the Family Plethodontidae, Smith College, Fiftieth Anniversary Publications 1926, pp 400-403, fig 73, map

1850 *Oedipus variegatus* Gray, Cat Batr Grad British Mus , 1850, p. 48, Ann. Mag. Nat Hist , 2, 1858, p 300, Moore, Proc. Acad Nat. Sci Philadelphia, 1900, p. 619; Fowler and Dunn, Proc Acad. Nat Sci Philadelphia, 1917, p. 19

1854 *Bolitoglossa Mexicana* Duméril and Bibron (*part.*), Erp Gén , V, 9 1854, p. 93, pl , 104, fig. 1 (Dolores, Petén, Guatemala)

1860. *Geotriton carbonarius* Cope, Proc Acad Nat Sci. Philadelphia, 1860, p 373; (type description; type locality, Jalapa, Mexico); Journ Acad. Nat. Sci. Philadelphia (2), 6, 1866, p. 98

1869. *Oedipus carbonarius* Cope, Proc Acad. Nat Sci Philadelphia, 1869, p 103; and Proc. Amer. Philos. Soc., 1879, 18, p 267; Sumichrast, Bull Soc Zool. France, 1881, p. 231; and La Naturaleza, 6, 1882, p. 78.

1870. *Geotriton variegata* Garman, Bull. Essex Inst , 16, 1884, p. 39

1883. *Spelerpes Mexicanum* Brocchi, Mission Scientifique au Mexique, Etude sur les Batraciens, livr. 3, 1883, p. 113, pl. 18b, figs. 1, 2, 3, 4.

1883. *Spelerpes Copei* Brocchi, *loc. cit.*, p. 113

1883. *Spelerpes punctatum* Brocchi, *loc. cit.*, p. 115, pl. 20, figs 345 (type description; type locality, Alta Vera Paz, Guatemala)

1870. *Spelerpes variegatus* Strauch, Mem. Acad. Sci. St. Petersbourg (7), 16, 4, p. 84; Muller, Verh. Naturf. Ges. Basel, 1878, 6, p. 579; Boulenger, Cat. Batr. Grad. s caud., 2d ed. 1882, p. 73, Lönnberg, Zoöl. Anz., 1899, p. 545; Gunther, Biologia Centrali-Americana, Batr. Rept., Jan., 1902, pp. 302-303, pl. 75, figs. A. B. C.; Werner, Abh. Bayer Akad., 22, 1903, p. 352; Gadow, Proc. Zoöl. Soc. London., 1905, p. 203; and Zool. Jahrb., 1910, p. 305; Ruthven, Zoöl. Jahrb., 23, 1912, p. 305; and Rept. Michigan Acad. Sci . 14, 1912, p. 231.

1884. *Geotriton varegata* Garman, Bull. Essex Inst., 16, 1884, p. 39.

1884. *Geotriton Mexicana* Garman, Bull. Essex Inst. 16, 1884, p. 40.

1894. *Spelerpes Mexicana* Dugès, La Naturaleza (2), 2, 1894, p. 377.

The collection contains specimens of this species from the following localities: EHT-HMS, Nos. 3964, 15 mi. S. Valles, San Luis Potosí, June 13, 1932, E. H. Taylor and Hobart M. Smith, collectors; 15200, near San Lorenzo, Cordova, Veracruz, Aug. 19, 1936, E. H. Taylor, collector; 15201, Potrero Viejo, Veracruz, Aug. 23, 1937, E. H. Taylor, collector; 15202, 5 miles each of Córdova, Veracruz, H. R. Roberts, collector.

Description of species. (From EHT-HMS, No. 15202.) A large *Oedipus*, the body moderately robust. Head seen from above, truncate oval, the eyes moderately prominent, extending slightly beyond outline of head; nostrils small, with a prominent swelling below them near the lip about the groove; length of eye slightly greater than its distance to nostril, but longer than the snout; a groove from behind eye joins the first nuchal groove, which is continuous across the throat, though but dimly visible (strongly visible in No. 15200); second nuchal groove crosses neck and arises high on the side of neck; angle of jaw far back of posterior corner of the eye; posterior parts of eyelids fit under a fold of skin; body with thirteen costal grooves from axilla to groin; the limbs, where adpressed, separated by about four folds; limbs strong, both fingers and toes well developed, flattened, enclosed in webs; the anterior edges of the palmate hands and feet scalloped; anal slit without papillae; but the inner walls strongly folded; tail tapering gradually, slightly compressed.

Vomerine teeth in two curved series of 13 teeth each, almost in contact medially, extending to outer (lateral) edge of the choanae; a single large patch of parasphenoid teeth, separated from the vomerine teeth by the width of a choana.

Color. Above the color is light buff to fawn, and covers the whole dorsal surface, save head, which is more or less covered by a dark triangular patch, the apex of which extends back on the neck; a few lighter flecks on the head; sides of head, body and tail and all ventral surfaces dark plumbeous to blackish, practically uniform.

MEASUREMENTS OF OEDIPUS PLATYDACTYLUS (CUVIER)

	No. 15202	No. 15200
Snout to vent	72	43
Snout to jaw angle	9	6.8
Snout to gular fold	16.2	10.3
Snout to forelimb	21	13
Width of head	10	7
Axilla to groin	43.5	26.6
Arm	13	9
Leg	15	10
Tail	73	42

Variation. Nos. 15200 and 3964 have some black flecks or streaks on the back and tail. I recently examined a large specimen from Tamazunchale, San Luis Potosí, belonging to Mr. Ottys Sanders, Dallas, Texas, in which the lateral and ventral coloration was coal-black.

Remarks. Certain of the more striking color variants have been described as distinct species (*variegatus, carbonarius*); it seems likely that Dunn is correct in placing these in synonymy. However, the buff-colored form here discussed is apparently the typical *platydactylus*.

The specimens from San Luis Potosí carry the range much farther north than known heretofore.

Gymnopis multiplicata oaxacae Mertens

1930. *Gymnopis multiplicata oaxacae* Mertens, Abh. Ber. Mus Natur.—Heimatk. Natur. Ver. Magdeburg, Bd. VI, heft II, 1930, pp. 153-155, fig. 14 (from Blätter Aquar. Terr-Kunde 1928); (type description; type locality, Cafetal Concordia, 600 m. between Puerto Angel and Salina Cruz, Oaxaca, México; Lafrentz, collector)

A single specimen, EHT-HMS, No. 4604, of this rare form was collected by H. M. Smith on the hills east of Tonolá, Chiapas. It presents the following characteristics:

A total of 131 primary folds anterior to anus; the 13 anterior folds and the posterior 18 completely encircle the body—the total of primary and secondary folds on body and tail, 236; a strongly developed nuchal fold with lateral grooves meeting medially; first nuchal groove crosses throat, passes back of the angle of jaw and across the head; the area between the two aforementioned grooves partially divided by a short transverse groove on the dorsal part of the neck, and by a somewhat longer transverse groove on the throat; nostrils small, the distance between them (2.5 mm.) less than the distance between the nostril and the globular tentacle (3.2 mm.); eye to nostril (4.6 mm.) a little less than interorbital distance (5 mm.), which equals the length of snout; snout projecting 1.7 millimeters beyond mouth; 15-16 maxillary teeth on each side, inner, vomero-palatine series 16-18; a single series of teeth in lower jaw, 11-12 on each side, large, conical, much larger than teeth on upper jaw; two small papillae in the preanal region; four or five in the postanal region; a prominent lateral "fold" or "ridge" extends the length of the body.

Measurements (in mm.). Length of head to angle of the jaws, 11.1; width of head, 7.3; snout to gular fold, 12.5; total length, 340; tail, 2; body width, 10; body width in length, 34 times.

Remarks. It may be noted that this form departs from the typical generic characteristics in lacking the inner row of teeth in lower jaw; the teeth in general, instead of being small and subequal, are relatively large and vary greatly in size in the lower and upper jaws.

The specimen was found under a log burrowed in hard earth near to the top of the large hill about three miles east of Tonolá.

I acknowledge indebtedness to Dr. E. R. Dunn for the identification of this species under the name here used.

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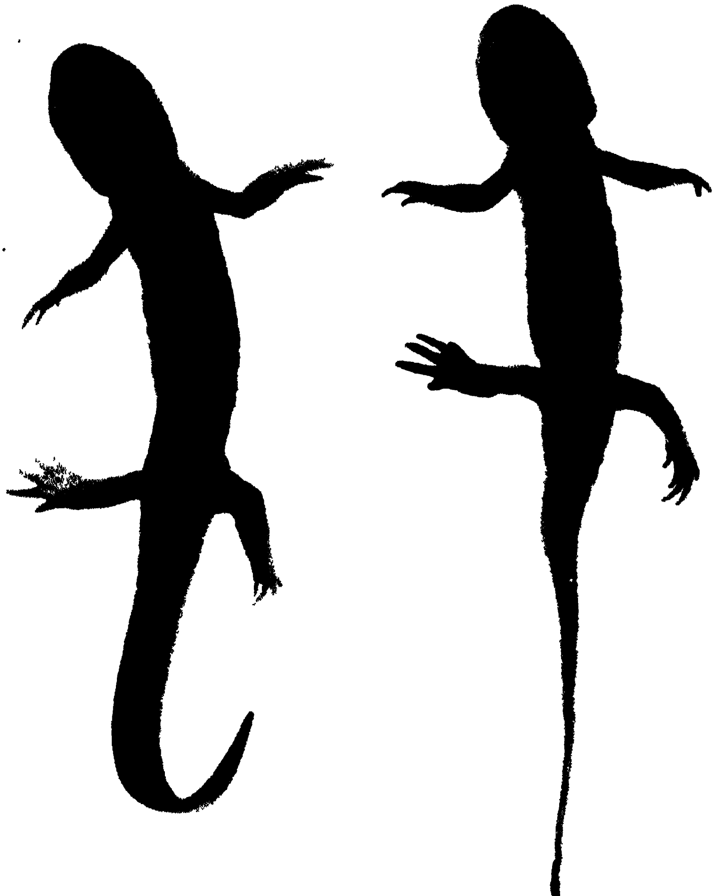
PLATE XXIV

FIG. 1. *Ambystoma sp.* Shaw. EHT-HMS. No. 3997. Rancho Guadalupe, near San Martin, Mexico; actual snout-to-vent measurement, 80 mm.; total length, 150 mm. Not discussed in text.

FIG. 2. *Ryacosiredon altamirani* (Dugès). EHT-HMS. No. 12511. Near Lake Zempoala, Morelos, 11,000 ft. elevation. Actual snout-to-vent length, 68.2 mm.; total length, 143.2 mm.

PLATE XXIV



1. 2.

PLATE XXV

FIG. 1. *Oedipus orizabensis* (Blatchley). EHT-HMS. No. 12067. Lake Zempoala, Morelos; actual snout-to-vent length, 53.5 mm.; total length, 99.5.

FIG. 2. *Oedipus orizabensis* (Blatchley). EHT-HMS. No. 12239 (same locality as 12067); actual snout-to-vent length, 56 mm.; total length, 105 mm.

FIG. 3. *Oedipus altamontanus* sp. nov. EHT-HMS. No. 12245. Type. Near Lake Zempoala, Morelos; 10,500 feet; actual snout-to-vent length, 48.6 mm.

FIG. 4. *Oedipus altamontanus* sp. nov. EHT-HMS. No. 12239. Paratype. Same locality; actual snout-to-vent length, 40 mm.

FIG. 5. *Oedipus smithi* sp. nov. EHT-HMS. No. 3965 ♂. Paratype. Cerro de San Luis, Oaxaca, Oaxaca; actual snout-to-vent length, 69 mm.; total length, 139 mm.

FIG. 6. *Oedipus smithi* sp. nov. EHT-HMS. No. 3966 ♀. Type. Cerro de San Luis, Oaxaca, Oaxaca; actual snout-to-vent length, 69 mm.; total length, 145 mm.

PLATE XXV

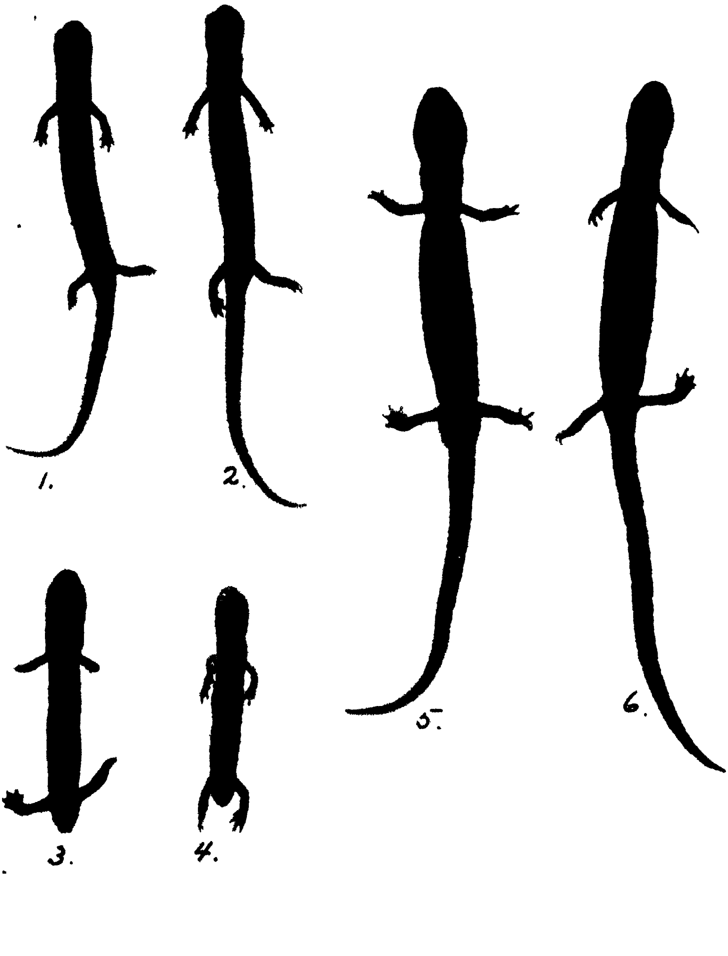


PLATE XXVI

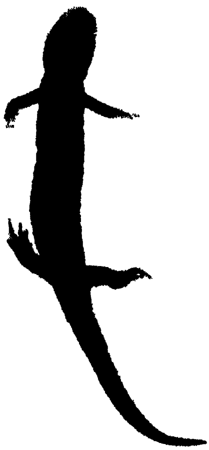
FIG. 1. *Ambystoma schmidti* sp. nov. EHT-HMS. No. 3999. Type. Rancho Guadalupe, 10 mi. E. San Martin (Asuncion), México; actual snout-to-vent length, 52 mm.; total length, 89 mm.

FIG. 2. *Oedipus robertsi* sp. nov. EHT-HMS. No. 12503. Nevada de Toluca, México, between 10,000 and 11,000 feet; actual snout-to-vent length, 51 mm.; total length, 95.8.

FIG. 3. *Oedipus cephalicus* (Cope). EHT-HMS. No. 4539 ♂; east of Rio Frio, Puebla, Mexico. Actual length snout to posterior part of vent, 49.5 mm.; total length, 98 mm.

FIG. 4. *Oedipus cephalicus* (Cope). EHT-HMS. No. 4536 ♀; east of Rio Frio, Puebla, Mexico. Actual snout-to-vent length, 56.5 mm.; total length, 110 mm.

PLATE XXVI



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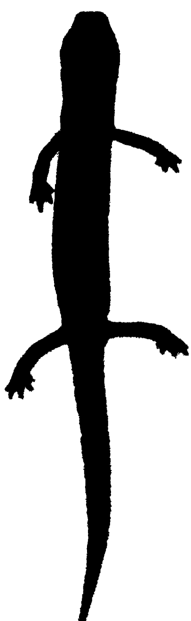

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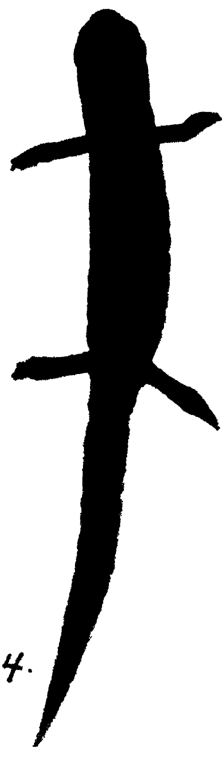

4.

PLATE XXVII

FIG. 1. *Oedipus bellii* (Gray). MCZ. No. 3935, Guerrero, Hidalgo, Mexico. Actual head-body length, 103 mm.

FIG. 2. *Oedipus bellii* (Gray). MCZ. No. 3938, Guerrero, Hidalgo, Mexico. Head-body length, 53 mm.

FIG. 3. *Oedipus giganteus* sp. nov. MCZ. No. 8434, Jalapa, Veracruz, Mexico. Head-body length, 46 mm.

FIG. 4. *Oedipus giganteus* sp. nov. Type. MCZ. No. 8435, Jalapa, Veracruz. Head-body length, 110 mm.

PLATE XXVII

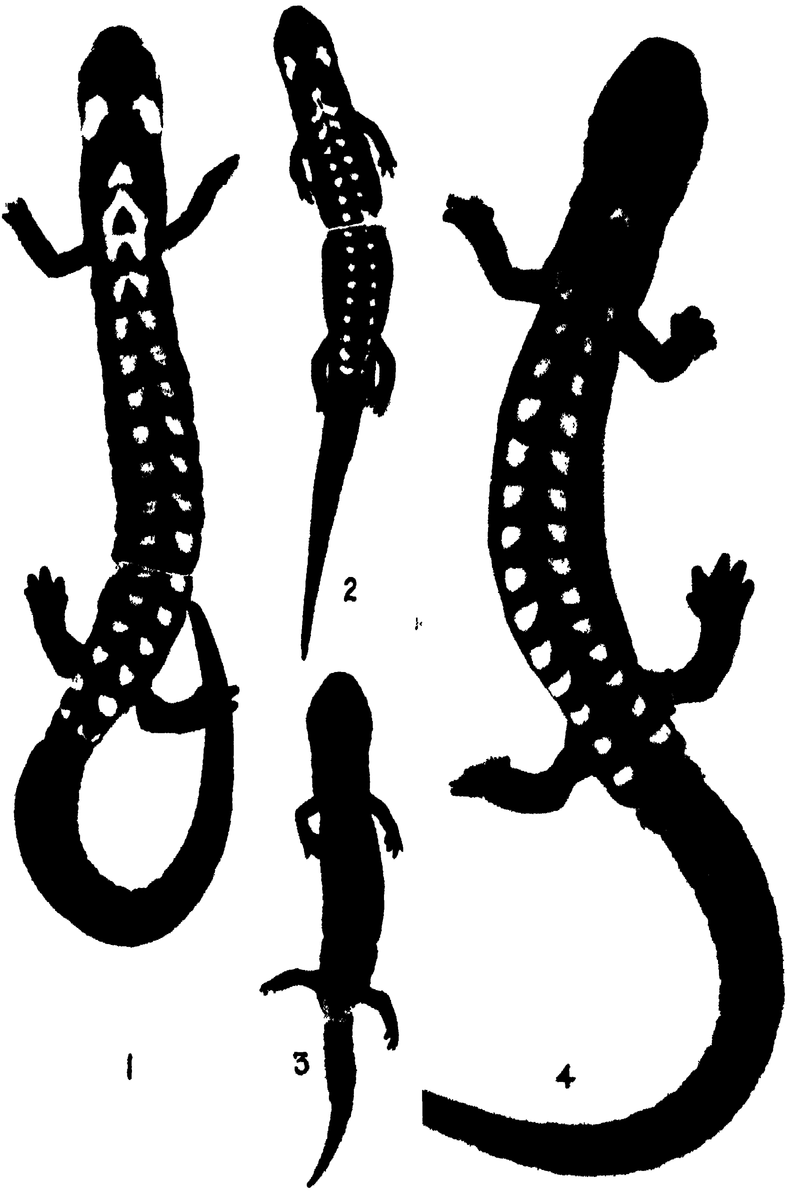

PLATE XXVIII

FIG. 1. *Oedipus platydactylus* (Cuvier). EHT-HMS. No. 15202, 5 miles east of Córdova, Veracruz, Mexico. Head-body length, 72 mm.

FIG. 2. *Oedipus salvinii* Gray. EHT-HMS. No. 3995 ♀, (?) Tonolá Chiapas, Mexico. Head-body length, 81 mm.

PLATE XXVIII

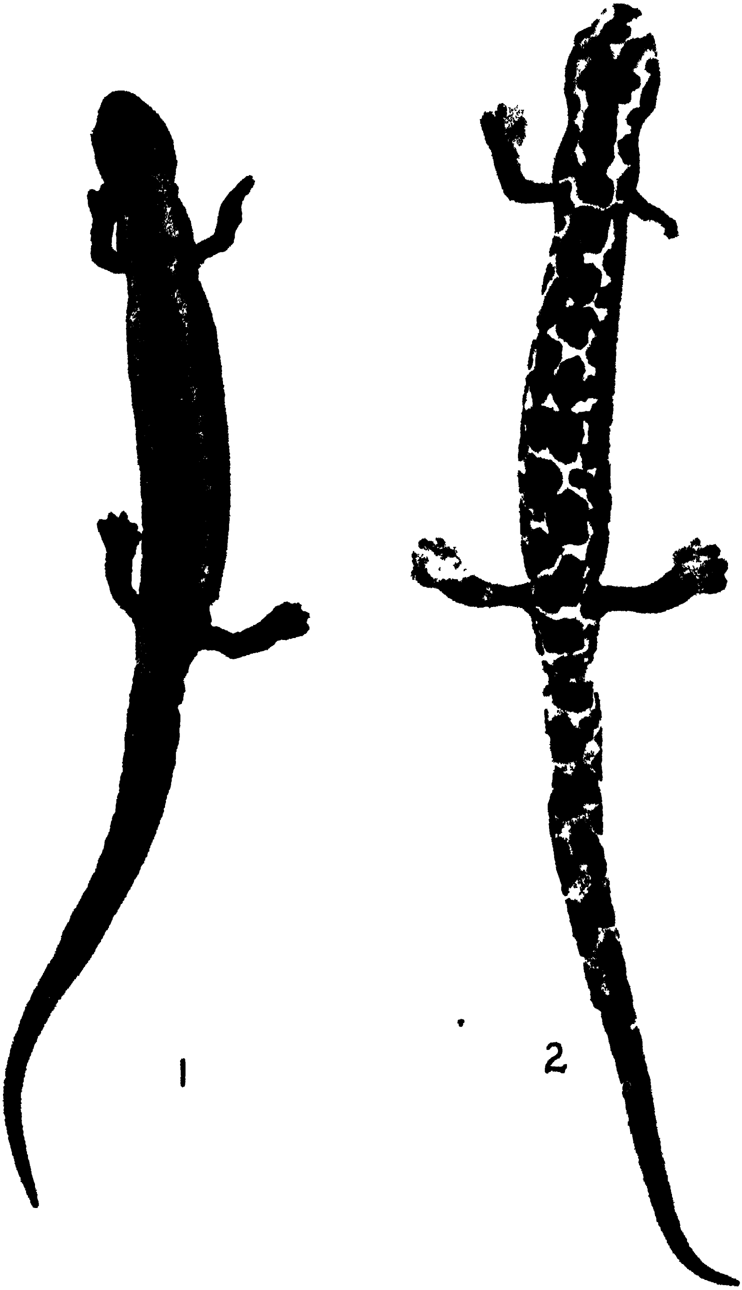

PLATE XXIX

FIG. 1. *Oedipus multidentata* sp. nov. Type. MCZ. No. 14812, Alvarez, San Luis Potosí, Mexico. Head-body length, 39.5 mm.

FIG. 2. *Oedipus leprosus* (Cope). MCZ. No. 7659, Zometla, Orizaba, Mexico. Head-body length, 57 mm.

FIG. 3. *Oedipus lineolus* (Cope). EHT-HMS. No. 2415. Near Córdova, Veracruz, Mexico. Total length, 86 mm.

FIG. 4. *Oedipus manni* sp. nov. MCZ. No. 3916. Guerrero, Hidalgo, Mexico. Head-body length, 48 mm.

FIG. 5. *Oedipus manni* sp. nov. MCZ. No. 3915. Type. Guerrero, Hidalgo, Mexico. Head-body length, 53.2 mm.

FIG. 6. *Oedipus manni* sp. nov. MCZ. No. 3925, Guerrero, Hidalgo, Mexico. Head-body length, 46 mm. Ventral view.

PLATE XXIX

THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

VOL. XXV] JUNE 1, 1938 [No. 15

Notes on the Mexican Snakes of the Genus Leptodeira, with a Proposal of a New Snake Genus, Pseudoleptodeira

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ABSTRACT: The work is based on specimens of *Leptodeira* in the collections made in Mexico by Dr. Hobart Muir Smith and the author. The following Mexican species are recognized as belonging to the genus: *Leptodeira punctata* (Peters), *L. splendida* Günther, *L. mystacina* Cope, *L. duncheri* Werner, *L. septentrionalis* (Kennicott), *L. frenata* (Cope), *L. maculata* (Hallowell), *L. yucatanensis yucatanensis* Cope, *L. yucatanensis mallisi* Dunn and Stuart; *L. bressoni* sp. nov. (type locality, El Sabino, Uruapan, Michoacán), *L. smithi* sp. nov. (type locality, El Sabino, Uruapan, Michoacán).

L. latifasciata (Günther) and *L. discolor* (Günther) are placed in a new genus *Pseudoleptodeira*, while the genus *Hypsiglena* Cope *sensu strictu* (including the species *torquata, ochrorhynchus and affinis*) is not regarded as being a synonym of the genus *Leptodeira*.

AN interpretation of the species of the genus *Leptodeira* Fitzinger, acceptable to herpetologists in general, appears to be difficult to formulate; at least previous studies by numerous authors have failed to bring about anything approaching a unanimity of opinion. That workers have differed in their treatment of the genus may be due, in some cases, to inadequate material available for study; in other cases, to a different concept of genera and species, or to the individual's technique of study. It is significant that, with practically the same specimens before them, such experienced workers as Günther and Boulenger should have arrived at such diverse results when dealing with this genus. While a complete review of the literature is impractical here, it is pertinent that a few, more important contributions be briefly reviewed.

Günther (1858) studied the American specimens of this genus in the British Museum (64 specimens) and placed all in a single spe-

cies, *Leptodeira annulata* (Linné). These specimens were Mexican, Central American, and South American. Later Günther (1895) and Boulenger (1896) recognized four species in this same lot of material.

Günther (1895) reviewed the Mexican and Central American forms in the British Museum in the Biologia Centrali-Americana, May, 1895, pp. 168-174, pls. LIII, fig. B, LIV, figs. A, B, and C, LV, figs. A, B. Eight known species were recognized as follows: *Leptodeira nigrofasciata* Günther (1868); *L. pacifica* Cope (1869); *L. mystacina* Cope (1869); *L. annulatus* (Linné) (1754); *L. yucatanensis* Cope (1887); *L. personata* Cope (1869); *L. frenata* (Cope) (1887); *L. rhombifera* Günther (1872). Four new species were described, and three were figured in this same work: *L. affinis*, *L. splendida*, *L. polysticta*, and *L. ocellata*.

Kennicott's species, *Dipsas septentrionalis*, was placed in the synonymy of *L. annulata* (Linné); and Peters' *Crotaphopeltis punctata* was not recognized as a Mexican form. Cope's *Sibon septentrionale rubricatum*, Lacépède's *Coluber albofusca*, and Hallowell's *Megalops maculatus* were not allocated.

It has been impossible to determine exactly the number of specimens available to Günther, but the year following the publication of his work there were 79 specimens from Mexico and Central America, and 26 from South America in the British Museum, as listed by Boulenger.

Boulenger, in 1896, reviewed the entire genus, having at hand the same and probably no more specimens than were available to Günther. His conclusions were strikingly different. He recognized in the Mexican-Central American region only seven species, as follows: (1) *Leptodeira punctata* (Peters), which included *L. pacifica* Cope; (2) *L. nigrofasciata* Günther, including *L. mystacina* Cope; (3) *L. frenata* (Cope); (4) *L. septentrionalis* (Kennicott); (5) *L. personata* Cope, in which were included *L. rhombifera* Günther and *L. splendida* Günther; (6) *L. ocellata* Günther, in which was placed *Sibon septentrionale rubricatum* Cope (with a question); (7) *L. albofusca* (Lacépède), with which were synonymized *L. yucatanensis* Cope, *L. polysticta* Günther and *L. affinis* Günther. *L. annulata* (Linné) was restricted to South America.

Cope (1900) published a key to the genus, in which he listed seven species. This was virtually a reprint of a key published earlier (1891), in which the same forms were recognized. He synonymized his *L. mystacina* with *L. nigrofasciata* and lists *L. pacifica, L. frenata, L. personata, L. yucatanensis, L. septentrionalis* and *L.*

annulata. It seems likely that he had not considered either Günther (1895) or Boulenger (1896) in fabricating the key published in 1900.

Mocquard (1908) treated of Mexican and Central American species in the Paris Museum. He accepted the disposition of species and their synonymies made by Boulenger, and adds another species, *Leptodeira guilleni*, described by Boulenger in 1905.

Werner (1913), in a key to species of *Leptodeira*, recognizes *L. dunckeri*, *L. punctata*, *L. nigrofasciata*, *L. frenata*, *L. septentrionalis*, *L. personata*, *L. guilleni*, *L. annulata*, *L. ocellata*, and *L. albofusca*.

Perhaps the most extraordinary treatment is that of Amaral (1929). He places all species of New World *Leptodeira* in a single species, *L. annulata*, and recognizes four subspecies, *L. a. septentrionalis*, *L. a. punctata* (with *nigrofasciata* in synonymy!), *L. a. personata* (with *L. frenata* and *L. guilleni* as synonyms!); *L. a. annulata* (includes *maculatus*, *albofusca*, *dunckeri*, *weiseri* as synonyms).

Dunn (1936) published some notes on North American *Leptodeira* proposing certain changes in the concept of the genus. He had available 957 specimens, of which 606 were referred to *L. rhombifera*. Of the total 400 consisted solely of heads.

Of *Leptodeira* (*sensu stricto*), Dunn recognized the following forms: (1) *Leptodeira annulata annulata* (including *affinis* Günther); (2) *L. annulata polysticta*; (3) *L. rhombifera* Günther (including *rubricatum* Cope, *splendida* Günther, and *ocellata* Günther); (4) *L. pacifica* Cope (placing *Crotaphopeltis punctata* Peters as a questioned synonym); (5) *L. yucatanensis yucatanesis* (Cope); (6) *L. yucatanensis malleisi* Dunn and Stuart; (7) *L. frenata* Cope; (8) *L. septentrionalis septentrionalis* (Kennicott); (9) *L. septentrionalis maculata* (Hallowell) (including *personata* Cope); (10) *L. mystacina* Cope; (11) *L. nigrofasciata* Günther.

Aside from these forms the following are included in the genus: *Hypsiglena torquata*, as *Leptodeira torquata torquata* Günther; *Hypsiglena ochrorhynchus* Cope as *Leptodeira torquata ochrorhynchus*; and *Hypsiglena venusta* (Mocquard) as *Leptodeira torquata venusta*; *Hypsiglena discolor* Günther as *Leptodeira discolor* and *Hypsiglena latifasciata* Günther as *Leptodeira latifasciata*, including as a synonym *Leptodeira guilleni* Boulenger.

Comments on these various proposals are discussed under the heading of the genus or individual species.

Since 1932 Dr. Hobart M. Smith and I have been segregating a

collection of Mexican amphibians and reptiles, among which are some 70 specimens belonging to the genera *Leptodeira* and *Hypsiglena.*

Due to the courtesy of Dr. Leonhard Stejneger and Dr. Doris Cochran I have recently examined, in some detail, Mexican specimens of *Leptodeira* in the United States National Museum and a number of Central American specimens as well. Doctor Hobart M. Smith obtained data and photographs of certain Mexican specimens in the Museum of Comparative Zoölogy at Harvard; Mrs. Helen T. Gaige has furnished information on a specimen in the Michigan collection. Dr. Emmet R. Dunn has placed certain data in my hands and has offered valued criticism. I offer my gratitude to these persons.

Genus *Leptodeira* Fitzinger

1826. *Sibon* (*part.*) Fitzinger, N. Class. Rept., pp. 29, 31; Cope, Proc. Ac. Phila., 1860, 266 (*septentrionalis*).

1837. *Coronella* (*part.*) Schlegel, Phys. Serp., II, 1837, p. 50 (*rufescens*).

1834. *Leptodeira* Fitzinger, Systema Reptilium, p. 27. Type, "*Dipsas annulata* Schlegel" [= *Leptodeira rhombifera* and *Leptodeira annulata* since this species of Schlegel is a composite of *Leptodeira rhombifera* Gunther and *Leptodeira annulata* (Linné).

1861. *Megalops* Hallowell (non Lacépède), Proc. Acad. Nat Sci. Phila , 12, 1861, p. 488. Type, *Megalops maculata.*

1866. *Leptodira* Cope, Proc. Acad. Nat. Sci. Phila., p. 127 (emendation).

I have hesitated to accept Dunn's proposal to unite, with this genus, Cope's *Hypsiglena* (type, *ochrorhyncha*). In his preliminary paper he gives but little data for such a change. There are present smaller series of teeth in the jaws; the fangs lack grooves; the elongation of the snout anterior to the mouth is much greater than obtains in typical *Leptodeira;* the tail is proportionally shorter, and the scales differ in having only a single apical pit instead of paired pits. Moreover, this genus has a distribution north of the Isthmus of Panama, nearly coextensive with *Leptodeira.* I believe this genus is a natural group worthy of generic recognition.

On the other hand *Hypsiglena latifasciata* Günther (which includes *Leptodeira guilleni* Boulenger* as an absolute synonym) and *Hypsiglena discolor* Günther have paired apical pits, shorter snouts, with fewer teeth that approach those of typical *Leptodeira* save that the large back fangs are lacking in grooves. These forms are extremely rare, *H. discolor* being known only from the two cotypes, and *H. latifasciata* from only five specimens.

I regard these two forms as members of neither *Hypsiglena* nor *Leptodeira.* I therefore propose for them a new generic designation.

* This form lacks grooved teeth, according to H. W. Parker, who at my request examined the types and furnished data on all three mentioned forms. He concurs with Dunn's suggestion that *H. latifasciata* and *L. guilleni* are synonyms.

Leptodeira punctata (Peters)

(Plate XXX, fig. 1)

1866. *Crotaphopeltis punctatus* Peters, Mon. Ber. Akad. Wiss. Berlin, 1866, p. 93 (type description; type locality, "South Africa" [probably Western Mexico]).

1869. *Leptodeira pacifica* Cope, Proc. Acad. Nat Sci. Phila., 1868 (1869), p. 310 (type description; type locality, Mazatlán, Bishoff, Coll.); Gunther, Biologia Centrali-Americana, Reptilia and Batrachia, 1895, p. 169; Boulenger, Cat. Snakes Brit. Mus., III, 1896, p. 19 (Presidio, near Mazatlán); Dunn, Proc. Nat. Acad. Sci., 22, 1936, pp. 691-694.

1887. *Sibon pacificum* Cope, Bull. U. S. Nat. Mus., No. 32, 1887, p. 67; and Proc. U. S. Nat. Mus., XIV, 1892, p. 678.

1887. *Leptodeira punctata* Boulenger, The Zool., 1887, p 178 (Africa).

1939. *Leptodeira annulata punctata*, Amaral, Mem. Inst. Butantan, IV, p. 929, p 204 (places *Leptodeira nigrofasciata* as a synonym).

1937 *Leptodeira punctata* Taylor, Univ. Kansas Sci. Bull. XXIV, 1936 (1937), pp. 526-527.

A single male specimen of this rare snake was captured late at night near a small railway bridge about a mile east of Mazatlán, Sinaloa. The specimen was crawling along the bank of a small rivulet which held water from a rain of the previous night.

It presents the following characters: Portion of rostral visible above very narrow; frontal longer than its distance from the end of the snout, shorter than the parietals; nostril very large, pierced chiefly in the anterior part of the divided nasal; loreal small, as high as wide; two preoculars, the upper very high, the lower minute; two postoculars, both in contact with the single large anterior temporal; posterior temporals two; diameter of eye equal to its distance from the middle of the nostril. Upper labials 7-7, the sixth extremely large, the third and fourth entering the eye; anterior chinshields slightly wider, but no longer than the posterior; latter scales separated from the first widened ventral by two pairs of small scales and two single enlarged scales; lower labials 9-9, the first four touching the chinshields. Ventrals, 149; anal divided (preceded by a very small median scale); subcaudals, 70. Length, 516 mm.; tail, 130 mm.; head width, 13 mm.; head length to angle of jaw, 19 mm.

Color in life. Above slightly reddish-brown with a series of black spots extending to the tail on either side of the median line; and on the side, one or two indefinite rows of irregular black flecks tending to form angular reticulations. Head brown; four small dark spots on the posterior head scales; a small median black spot borders the parietals and on either side of the nape are two large black spots narrowly separated by a yellowish area; no black bar behind eye; labials very light tan; ventral surface cream.

Dunn's use of *L. pacifica* Cope for this form rather than *L. punctatus* Peters is prompted by no new evidence.

Leptodeira splendida Günther

(Plate XXX, fig. 2; Text fig. 1)

1895. *Leptodeira splendida* Günther, Biologia Centrali-Americana, Reptilia and Batrachia, May, 1895, pp. 168, 170, pl. LIII, fig. B (type description; type locality, Izúcar, Puebla, México).

1896. *Leptodira personata* (*part.*) Boulenger, Cat. Snakes British Mus., III, 1896, p. 93 (types of *splendida*); Mocquard (*part.*), Mission Scientifique au Mexique, livr. 16, 1908, pp. 903-904.

1936. *Leptodeira rhombifera* (*part.*) Dunn, Proc. Nat. Acad. Sci., vol. 22, 1936, pp. 691-693.

Four specimens of this species are in the collection. Nos. 5177-5179, from a point 12 miles south of Puente de Ixtla, Morelos (E. H. Taylor, collector), and No. 5478, from Cuernavaca, Morelos (H. M. Smith, collector).

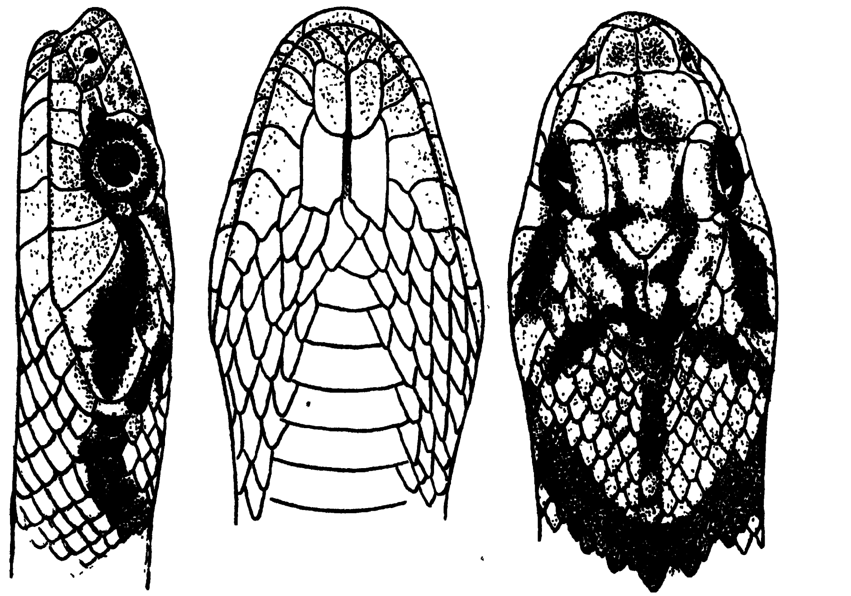

FIG. 1. *Leptodeira splendida* Günther, EHT-HMS. No. 5179, twelve miles south of Puente de Ixtla, Morelos, México (enlarged).

This species has been confused with both *personata* and *rhombifera*. It occurs in Morelos, and Puebla. It may be characterized by the presence of a stripe or bar on the nape; the peculiar head pattern; the presence of three preoculars (likewise typical of *septentrionalis, frenata* and *polysticta*); a reduced number of small dorsal spots, 19-25; 21 scales about middle of the body; ventrals, 165-168; subcaudals, 76-80. The posterior fangs are deeply grooved. The spots reach on the sides to the third or fourth scale rows, often tending to break medially or to become confluent. The following table shows the variation obtaining in this form.

Table of data and measurements in mm. of *Leptodeira splendida* Günther

Number	5178	5179	5478	5177	Type
Sex	♂	♂	♀	♂	♀ ?
Ventrals	168	167	167	166	165–66
Subcaudals	80	79	76	79	76
Preoculars	3–3	3–3	3–3	3–3	3–3
Postoculars	2-2	2–2	2–2	2–2	2–2
Temporals	1+2+3	1+2+3	1+2+3	1+2+3	1+2+3
Scale formula	21–21-17	19–21 16	21–21-17	21-21-16	—21—
Length, total	490	473	362	273	650
Length, tail	129	122	89	70	162
Spots, body	25	23	19	23	20
Spots, tail	20+	20+	15+	14++	....

Günther's type specimen is a relatively large one and the pattern on the dorsal surface of the head has more or less disappeared. (It is less distinct in my No. 5178.) One of the most striking differences between this form and *rhombifera* is the presence in males of keels on the scales along the posterior fourth or fifth of the body and on the base of the tail. In females the keels are barely discernible, which probably accounts for the fact that they are not recorded in the type. The constancy of three preoculars is likewise a pertinent character. The grayish or grayish-brown spotting is likewise in contrast to the brown or blackish-brown coloration of typical *rhombifera*.

The intercalated lateral spots are present but small, often somewhat elongate. The body is not compressed; the chinshields are of about equal length. The preocular touches the frontal in two cases; they are separated in two cases.

I believe this form to be more closely related to *Leptodeira bressoni*, described herein, than to *rhombifera*.

Leptodeira bressoni sp. nov.

(Plate XXXI, fig. 4; Text fig. 2; Plate XXXIII, fig. 4)

Type. EHT-HMS, No. 5172, collected at Hda. El Sabino, about 20 miles south of Uruapan, Michoacán. Don Julio Raymond Bresson, collector.

Paratypes. Nos. 4617, El Sabino, Michoacán, July 21-28, 1935, H. M. Smith, collector; 4619, near Queseria, Colima, June 18, 1935,

H. M. Smith, collector; 5173, Hda. El Sabino, 1935, Don Julio Raymond Bresson, collector.

Diagnosis. Related to *L. splendida*, but differing from it in color and scale characters. Scales in 19-21 rows; a dark nape stripe; the lines behind the eyes tending to join the first nuchal dark mark and usually separated by only a very short distance.

Ventrals, 168 to 182; subcaudals, 81 to 90; upper labials, 8-8; lower labials, 10-10; temporals, 1 + 2 + 3; dorsal scales keeled on pos-

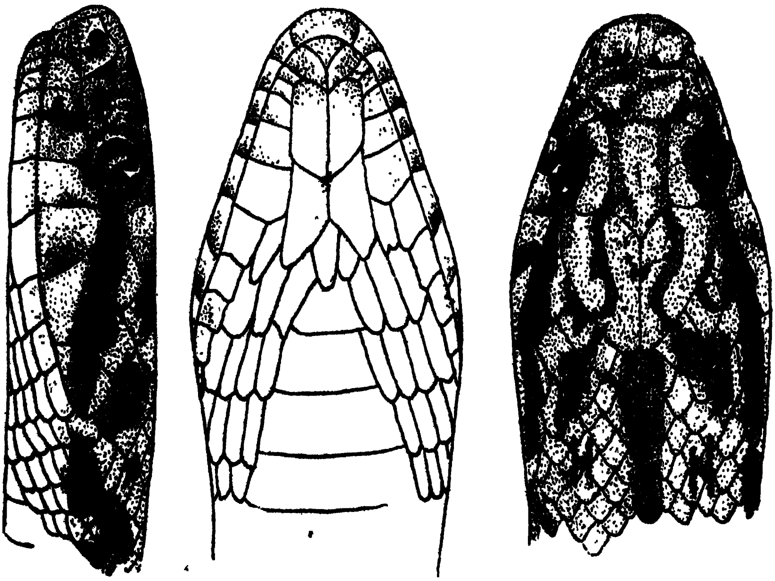

FIG. 2. *Leptodeira bressoni* sp. nov. Paratype. EHT-HMS, No. 5173. Hda. El Sabino, Uruapan, Michoacán (enlarged).

terior fourth or fifth of body; a bar on the nape of the neck, but not joining the first dorsal mark. Dorsal spots, 32-38; lateral intercalated spots prominent.

Description of the type. Rostral barely visible from above, its width once and one third its height; internasals typically small, their areas about one third that of prefrontals; latter large, distinctly wider than long; frontal much wider than long, its length equal to its distance from tip of snout; parietals typical, their length about one and one half times their width; nasal divided, or at least partially so; loreal slightly longer than high; three preoculars, the upper more than double size of middle one, not touching frontal; lower preocular (subocular) very small, separating third labial from eye;

supraocular widened posteriorly; temporals, 1+2+3; two postoculars; upper labials, 8-8, fourth and fifth entering orbit, having the following order of size, 1, 3, 2, 4, 5, 8, 6, 7; lower labials, 8-9 (abnormal, due to fusion of the ninth and tenth on one side); the posterior chinshields are longer than the anterior, pointed behind, separated from first widened ventral by two pairs of scales. Scale formula, 19-21-17; scales of the dorsal rows with keels on posterior fourth of body, growing more pronounced posteriorly above the base of tail; some of the keels are not continuous; some have a slight, knoblike termination. Ventrals, 171; subcaudals, 84; anal divided, lengthened abnormally, preceded by an unequal pair of scales.

Color. The general ground color is a rosy flesh. The body has a series of spots continuous across the middle of the back or broken medially and tending to alternate, but usually in contact. When broken the parts are quadrangular. The number of spots and pairs of spots on body, 38; on tail, 24+. On the intervening areas of ground color, there is an indistinct darker band which traverses the body from the first or second scale rows. The primary dark blotches reach to fifth scale row, and below these are indistinct blotches reaching to the ventrals. These intercalated markings are visible in the very young, the lower parts being darkest. First dorsal blotch forms a V-shaped mark, which is about three scales wide on the middorsal line; the bar on the nape beginning at the parietals extends back between the anterior arms, but does not touch the spot; a black bar from the eye runs to posterior edge of the eighth labial; this is followed by a small dark spot at a short interval. The top

Table of scale data and measurements in mm. of *Leptodeira bressoni*

Number	5172	5173	4617	4619	MCZ 11411	USNM 46459
Sex or age	♂	♂	♂	yg.	♀	♀
Ventrals	171	168	177	169	172	182
Subcaudals	84	90	81	82	71	78
Upper labials	8-8	8-8	8-8	8-8	8-8	8-8
Lower labials	8-9	10-10	10-10	10-10	10-10	10-10
Preoculars	3-3	3-3	3-3	3-3	3-3	3-3
Postoculars	2-2	2-2	2-2	2-2	....	2-2
Temporals	1+2+3	1+2+3	1+2+3	1+2+3	....	....
Scale formula	19-21-17	19-19-17	21-19-17	21-21-17	21-19-17	21-21-17
Length, total (mm.)	481	430	335	210	372	548
Length, tail (mm.)	124	118	89	53	107.5	128

of the head is variously mottled with black, but is injured so that no definite pattern can be discerned. The ventral surface is rosy flesh; the lateral edges of the ventrals with scattered dark pigmentation; the anterior chin scales likewise with some dark pigment; subcaudals with very slight pigmentation near tip of tail.

Variation. Dr. Emmet R. Dunn called my attention to the fact that MCZ, No. 11411, Colima, Mex. (plate XXXIII, fig. 4), probably belonged to this form. An examination proves that such is the case. It agrees very well, falling within the variation observed in the Michoacán specimens. Being a female, the ventral count is somewhat lower. The spotting on the body is irregular (31 on one side, 34 on the other, due to the fact that certain spots have broken apart). The tail has 12 spots on one side, 13 on the other. Dorsal scales are keeled on posterior part of body. Stippling present on chin and on under side of tail.

I am likewise associating with this species USNM No. 46459, Plomosas, Sinaloa; Nelson and Goldman, collectors. It is a female, with a slightly reduced subcaudal count; the general head and neck pattern is generally similar but somewhat obscured, due to injury to the top of the head. The most pertinent difference is that the spots are transverse, larger, wider, not tending to break medially. They extend to the second scale row, with some smaller spots on the first row below the lateral ends of the dorsal spots. The large spots are two and one half to three scales long on dorsal surface. The spots are brownish-gray, darker on their edges.

The number of spots on the tail is 18-19, fewer than in the type. The scales are keeled on the posterior fourth of the body. The fangs are grooved. The frontal is shorter than its distance to the tip of the snout.

It is probable that with a considerable series from this region it might be possible to separate this from the typical *L. bressoni* as a subspecies.

Remarks. This form has the dorsal spots varying in number between 32 and 38. In the youngest specimen, No. 4619, the flesh color is less pronounced.

This species is named for Don Julio Raymond Bresson, Dr. Smith's host at Hda. El Sabino, who showed him every courtesy and contributed much in the way of assistance in collecting, and presented him with many specimens.

The species differs from *Leptodeira splendida* in having a different pattern on the head, larger number of spots on the body, 32-38

(19-25 in *L. splendida*), the presence of a heavy reticulation on the ground color, and a somewhat higher ventral count, 167 to 182, instead of 165 to 168.

Leptodeira mystacina Cope

1869. *Leptodeira mystacina* Cope, Proc. Amer. Philos. Soc., XI, 1869, 151 (type description; type locality, "Western Région of Mexico near the isthmus of Tehuantepec." Two specimens, F. Sumichrast, collector); Günther, Biologia Centrali-Americana, Rept. Batr., May, 1896, p. 169 (description of specimen not the type); Dunn, Proc. Nat. Acad. Sci., 22, No. 12, Dec., 1936 (Acapulco, Guerrero, and Tapanatepec, Oaxaca).

1887. *Sibon mystacinum* Cope, Bull. U. S. Nat. Mus., No. 32, 1887, p 67 (Nicaragua and West Tehuantepec).

1892. *Sibon nigrofasciatum* Cope, Proc. U. S. Nat. Mus., XIV, 1892, p. 678 (Unites *L. nigrofasciata* and *L. mystacinum* and gives generic key); and Ann. Rep. U. S. Nat. Mus., 1898 (1900), p. 1107.

1896. *Leptodeira nigrofasciata* (*part.*) Boulenger, Cat. Snakes British Mus., vol. III, 1896, p. 92 (specimen from Tehuantepec); Mocquard, Mission Scientifique au Mexique et dans l'Amérique Central, livr. 16, 1908, pp. 900, 901 (description of a Tehuantepec specimen).

Opinions as to the distinctness of this form have differed. Cope, 1892, regards his own species a synonym of *L. nigrofasciata* Günther, which was described some months earlier than *L. mystacina* Cope. Günther, who had available a specimen from Tapana, Tehuantepec, likewise collected by Sumichrast, regarded the species distinct from his *L. nigrofasciata*, in spite of Cope's action, which Günther mentions in a footnote. Mocquard (1908) with three specimens collected by Sumichrast in Tehuantepec, either on his own judgment or on Cope's action, regards them as *L. nigrofasciata*. Dunn, 1936, with 13 Nicaraguan, and 2 Costa Rican specimens, together with Cope's types of *L. mystacina* and three additional specimens from Guerrero and Oaxaca, México, accepts them as distinct species. The following distinguishing characters are presented in the key:

L. nigrofasciata: 15-18 bands; ventrals, 168-172; Nicaragua and Costa Rica.
L. mystacina: 10-12 bands; ventrals, 187-196; Guerrero and Oaxaca.

The higher ventral count of *L. mystacina* as well as the reduced number of bands seem to warrant the retention of *L. mystacina*. Certainty as to whether intergradation occurs will have to await more extensive collecting in territory between the known ranges.

The following data were taken from specimens in the U. S. National Museum.

The cotypes (Nos. 30339-40, Tehuantepec, México; Sumichrast, collector) present the following characters:

No. 30339: Rostral visible above as a line; frontal narrow, elongate, distinctly longer than its distance from end of snout; parietals much widened anteriorly; prefrontals very large, forming an angle

laterally on right side; preoculars 2, 2, the upper very large—much widened and much elongated, forming a suture with frontal, more or less angular on its anterior edge, pushing between prefrontal and loreals; upper labials, 8 (right), 7 (left, 2 anterior labials abnormally fused); the sixth labial on right side touches upper postocular, but is minutely separated from the parietal; the fifth labial touches the parietal on the left side; lower labials, 10-10; postoculars, 1, 2; temporals 1+1+2+3; scale formula, 23, 19, 19, 17; ventrals, 187; caudals, 69; 11½ spots on body counted from one side, 13½ on the other; posterior chinshields separated; the head does not have the scales outlined with lighter color, and there is a very slight segregation of pigment at the anterior edges of the parietals and toward their posterior parts; a dark line in front of eye, continued behind eye to angle of mouth, and a second line below eye, diagonally to labial border, separated from the other dark line by a light line; upper labials with dim markings; on body there is a segregation of pigment to the edges of the scales of the dark spots.

No. 30340: General characters the same; preoculars, 2-2; postoculars, 2-2; the labials narrowly separated from the parietals; temporals, 1+2+3; second chinshields partially separated; 11½ spots on body; 4½ on tail, no evidence of pigment segregation on dorsal surface of head. Ventrals, 194; subcaudals, 65.

No. 46551: (Nelson and Goldman, Acapulco, Guerrero, 1895). Agrees with the preceding specimens in general characters. Scale formula, 23, 17, 19, 17; preoculars, 2, 2; postoculars, 1, 1, the lower apparently fused to the fifth labial, which rises as high as middle of the eye; temporals, 1+2+3; upper labials, 8-8; lower labials, 9-9; chinshields of equal length, the second pair separated; ventrals, 192; subcaudals, 65. Body with 11 deep lavender spots, the two sides not the same, since one half of each spot has moved forward nearly a half its length; each scale of the dorsal spots has a lighter center, thus giving the marking a reticulated appearance; each spot has a darker border; intervening ground color distinctly lighter, lightest where it contacts the dark spots; three spots on tail, not strongly distinct from intervening spaces. A brown line from nostril to eye, and from eye to jaw angle; a light line along the upper part of upper labials anteriorly, which turns down across posterior labials; a strongly defined dark line from below eye on fifth and sixth labials; chin powdered with dark pigment which forms indistinct spots; the lateral coloration encroaches on the ventrals; ventral surface of tail pigmented. Top of head stippled lightly with lavender-brown.

Leptodeira danckeri (Werner)

1913. *Leptodeira dunckeri* Werner, Mitt. Nat. Mus. Hamburg, 1913, 30, pp. 28, 29 (type description, type locality, "Mexico oder, Venezuela"; also a key to the American species of the genus).
1929. *Leptodeira annulata annulata*, (*part.*) Amaral, Mem. Inst. Butantan, 4, 1929, p. 204.
1936. *Leptodeira septentrionalis maculata* (*part.*) Dunn, Proc. Nat. Acad. Sci., 22, 1936, p. 691.

Dunn has regarded this species as being probably Mexican and has placed it as a synonym of *Leptodeira septentrionalis maculata* (Hallowell).

The form is diagnosed as having twenty-one scale rows, 183 ventrals, seven supralabials, one preocular, one postocular; whitish with twenty-five dark red-brown transverse bands which reach to the ventrals, narrowing on the sides, some of which bands are in contact dorsally, tending to form a zig-zag band. Between the dark bands near the ventrals are larger dark flecks. Two spots, side by side, on the parietals; snout darkly punctate: upper labials flecked with dark color; underside white.

It may be noted that the form differs from Mexican *Leptodeira maculata* in the presence of a single postocular instead of two, one preocular instead of two (one occasionally in western "*personata*"), seven instead of eight upper labials, 21 instead of 23 scale rows around the body (rarely 21 in *maculata*). The ventral count is higher than any Mexican specimen of *maculata* (Dunn gives 186 as maximum. I have not seen this specimen).

I feel that the evidence available does not wholly justify association of this name to the synonymy of *Leptodeira maculata* regardless of whether the specimen originated in Venezuela or México. The very brief description suggests a specimen more closely related to *L. yucatanensis malleisi* than to *L. maculata*. It has the scale rows of this form; one postocular (occasional in *malleisi*), the same number of bands, a ventral count within the range of the latter, and paired spots on the parietals, usually present in *malleisi*. However, this cannot be satisfactorily settled until the type of *L. danckeri* is studied in greater detail.

Leptodeira yucatanensis malleisi Dunn and Stuart

(Text Fig. 3)

1935. *Leptodeira yucatanensis malleisi* Dunn and Stuart, Occ. papers, Mus. Zoöl., U. of Michigan, No. 313, May 29, 1935, pp. 1-4 (type description; type locality, Tuxpena, Campeche, México); Stuart, Univ. Michigan, Mus. Zoöl., mis. publ. No. 29, Oct. 1, 1935, pp. 8, 24, 53; Gaige, Carnegie Inst. Washington publ. No. 457, p. 302; Dunn, Proc. Nat. Acad. Sci., 22, 1936, pp. 691, 696.

Two specimens of this form collected by Dr. Hobart Smith are in the collection, Nos. 11618 ♂ from Encarnacion, Campeche, and

11619 ♀, from Pital, Campeche, collected on October 14, and October 16, 1936. These have the following characteristics respectively: Scale formula, 19-21-15, 19-21-15; ventrals, 179, 188; subcaudals, 79, 67; supralabials, 8, 8; lower labials, 10-10; preoculars, 2-1, 2-2; postoculars, 2-2, 2-2; temporals, 1+2+3, 1+2+3; total length, 431 mm., 627 mm.; tail, 97 mm., 138 mm.; spots on body, 33, 28.

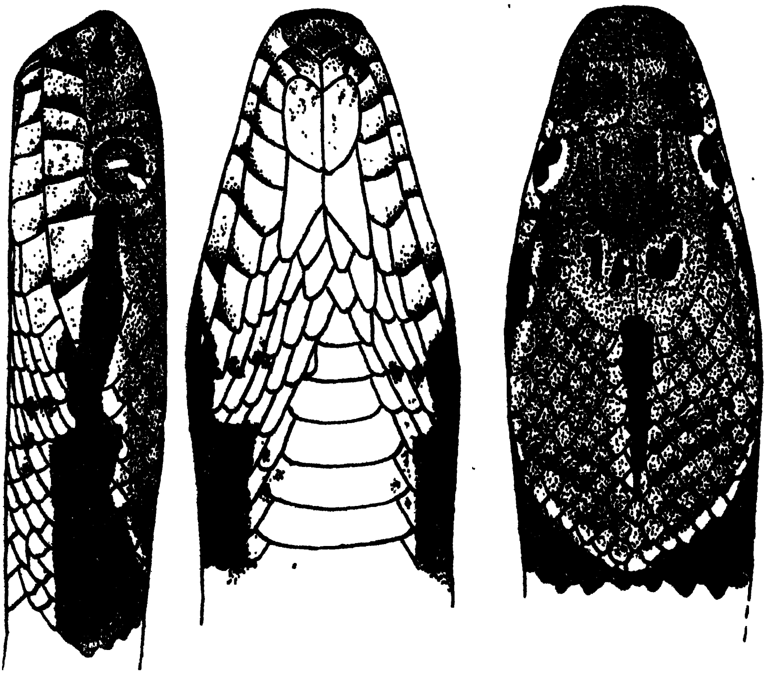

FIG. 3. *Leptodeira yucatanensis malleisi* Dunn and Stuart. EHT-HMS, No. 11619 ♀. Pital, Campeche, México (enlarged).

In No. 11619 the ground color and ventral surfaces are quite reddish. The black blotches are lighter in their centers and bordered by a thin whitish line. Many of the blotches are united, forming a zig-zag line on back. The blotches reach to the second or third scale row. Intercalated spots low on the side are distinct. There are also spots below the ends of the blotches; a nape stripe, not reaching the first nuchal blotch, and a pair of spots on the parietals. The lines from the eye reach the first nuchal blotch.

The smaller specimen is lighter pink on the ground color and ventral surfaces, and the spots are regular; the paired spots on the parietals are surrounded by a light ring.

Leptodeira yucatanensis yucatanensis (Cope)

Leptodeira annulata var. Cope, Proc. Acad. Nat. Sci., Philadelphia, 1866, p. 127.

Sibon annulata yucatanensis Cope, Bull. U. S. Nat. Mus., 32, 1887, p. 67 (type description by reference to Cope, 1866; type locality, Yucatán).

Leptodeira yucatanensis yucatanensis Gaige, Carnegie Inst. Washington Pub. No. 457, Feb. 5, 1936, p. 302 (Chichen Itza).

I have not examined specimens of this form.

Leptodeira septentrionalis (Kennicott)

(Plate XXXI, fig. 3; Text fig. 4)

Dipsas septentrionalis Kennicott, in Baird, Report Mexican Boundary Survey, 2, Rept., 1859, p. 16, pl. 8, fig. 11 (type description, type locality, Matamoras, Tamaulipas, México, and Brownsville, Texas; collected by Lieut. Couch and Van Vliet); Cope, Proc. Acad. Nat. Sci. Phila., 1860, p. 266.

Sibon annulatum septentrionale Cope, Check-list Batr. and Rept. N. Amer., 1875, p. 38; Bull. U. S. Nat. Mus., 1887, p. 67 (*part.*).

Sibon septentrionale (*part.*) Cope, Proc. U. S. Nat. Mus., XIV, 1891, pp. 677-678 (Key: ranges from Panamá to Cameron county, Texas); Ann. Rep. U. S. Nat. Mus., 1898 (1900), pp. 1007-1008, fig. 316 (Matamoras, Mex.).

Leptodeira septentrionalis Stejneger, Proc. U. S. Nat. Mus., XIV, 1891, p. 505.

Leptodeira annulata (*part.*) Günther, Biologia Centrali-Americana, Reptilia, 1895, p. 170.

Leptodeira septentrionalis Boulenger, Cat. Snakes British Mus., III, 1896, p. 93

Sibon septentrionalis Strecker, Baylor Bull., XVIII, No. 4, Aug. 1915, p. 41 (Cameron county, Texas)

Leptodeira septentrionalis septentrionalis Dunn., Proc. Nat. Acad. Sci., vol. 22, 1936, pp. 692, 697 (Cameron county, Texas, to Tampico, San Luis Potosi, México, Zacualtipan, Hidalgo, Mexico).

This large, robust form is represented in our collection by three specimens: No. 4615, seven miles west of Victoria, Tamaulipas; 4616, Hda. La Clementina, Tamaulipas; and 4652, uncertain locality.

This form may be diagnosed by the presence of three preoculars (pre- and suboculars); by the large black blotches touching or reaching near the first scale row; the high number of ventrals and subcaudals (186 to 197; 63 to 79, combination of data given by Dunn [1936] and my own data), and the presence of more or less pigment on the posterior edges of the ventrals; the scale count reduces to 15 in front of the anus. There is a black spot on the posterior edges of the parietals, usually confluent with an indistinct head pattern.

Data on the three specimens, Nos. 4615, 4616, and 4652, respectively, follows: Sex, ♂, ♂, ♂; ventrals, 193, 191, 186; subcaudals, 79, 81, 77; supralabials, 8-8, 8-8, 8-8; lower labials, 10-10, 10-10, 10-10; preoculars, 3-3, 3-3, 3-3; postoculars, 2-2, 2-2, 2-2; temporals, 1+2+3, 1+2+3, 1+2+3; scale formula, 26-21-23-15, 25-21-23-15, 26-21-23-15; rhombs on body, 23, 23, 24; spots on tail, 14, 12, 15; total length in mm., 785, 360, 256; tail, 180, 83, 55.

The black of the large spots is rather dense and does not show

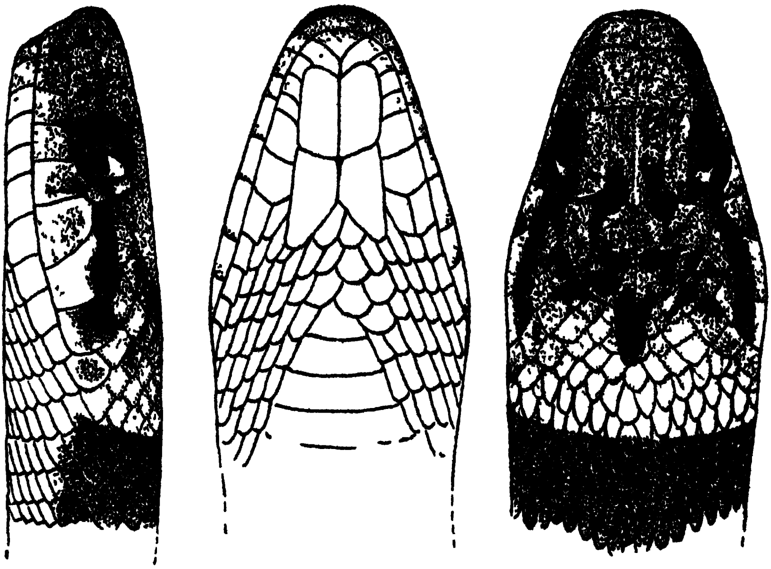

FIG 4 *Leptodeira septentrionalis* (Kennicott) EHT-HMS, No 4616 Hda La Clementina, near Forlon, Tamaulipas México (enlarged)

flecks of white The posterior teeth of the maxillae are strongly grooved.

Doctor Dunn has very kindly supplied data on specimens of *L septentrionalis* He lists from Zacualtipan, Hidalgo, ANSP Nos 11662 ♀, 11663 ♂, 14775 ♂ ' They have the following ventral counts, respectively: 197, 196, 197 All have three preoculars His specimen of *maculata* from this locality, ANSP No 14744 ♂, has only 167 ventrals and two preoculars

A series of *L septentrionalis* from Tuxpan, Veracruz, in the U S National Museum, Nos 25206 ♀, 25207, 25209, 25210, 25211 (the last four young), have the following ventral and subcaudal counts, respectively: 192, 80; 193, —; 191, 82; 201, 73, 201, 73 All reduce the scale count to 15 in front of anus The spots on the body vary between 27 and 33 The typical head marking and the small postparietal black spot are present The body spots are less square on the sides, tending to narrow more than in more northern forms, and the interspaces are somewhat wider. All have three preoculars.

Two of the cotypes (USNM No 4267, two specimens, Matamoras, Tamaulipas, México) are small. Each has three preoculars. The ventral counts are 186 and 189; the subcaudal counts, 77 and 64. Scale formulae, 17-21-15; 21-23-15. Another cotype mentioned, No. 2288, Brownsville, Tex., is not to be found It may be the speci-

men figured by Kennicott (*loc. cit.*). This specimen is abnormal in having several undivided subcaudals following the anus.

USNM No. 4273, from Matamoras, Tamaulipas, is the only specimen examined having the scale count of 17 one-half inch in front of vent. In all others it is reduced to 15.

Dunn (1936) has proposed the placing of *Leptodeira septentrionalis* as a subspecies of *L. maculata*, and suggests that *L. maculata* replaces the form off the plateau. The data here presented show a much greater overlap of the ranges than was hitherto suspected and in this range there is no evidence that the characters of the one approaches the general characteristics of the other. Because of this wide difference in the count of ventral scales, the presence of three instead of two preoculars, a different head pattern, and the pigmentation on the ventral scales, I regard the two forms specifically distinct.

Despite the fact that *Leptodeira polysticta* shows certain characteristics in common with *L. septentrionalis*, *i. e.*, scale counts within the same ranges, three preoculars and pigmentation on the posterior edges of the ventral scales, I am thoroughly convinced that the two forms are only remotely related.

Leptodeira annulata polysticta Günther

(Plate XXX, fig. 3)

Leptodeira annulata (*part.*) Gunther, Cat. Col. Snakes British Mus., 1858, p. 166.

Leptodeira polysticta Günther, Biologia Centrali-Americana. Reptilia and Batrachia, May, 1895, p. 172, pl. LV, fig. a (type description; type locality, México, Jalapa, Oaxaca, Yucatán; British Honduras, Belize; Honduras, and Panamá).

Leptodeira albofusca (*part.*) Boulenger, Cat. Snakes, British Mus., 1896, pp. 95-97; Mocquard (*part.*), Mission Scientifique au Mexique, etc., Rept., liv. 16, 1908, pp. 905-906; ? Werner Abh. Akad. Wiss., Bd. XVII, Abt. II, p. 348 (Coban, Guatemala); ? Shattuck, et al., The Peninsula of Yucatán, 1933, p. 575 (Yucatán).

? *Leptodeira annulata* Dunn and Emlen, Proc. Acad. Nat. Sci. Phila., LXXXIV, 1932, p. 32 (Rancho El Jarrac, Honduras); Sumichrast, Arch. Sci. Phys. Natur., 46, 1873, p. 246.

Leptodeira annulata polysticta Stuart, Misc. Publ. No. 29, U. of Michigan, Mus. Zoöl., Oct. 1, 1935 (La Libertad, Guatemala); Gaige, H. T., Carnegie Inst. Washington, Publ. No. 457, Feb. 5, 1936, p. 302 (Chichen Itza, Yucatán, Mexico); Dunn, Proc. Nat. Acad. Sci., 22, 1926, pp. 691, 698 (Colima, Southern Veracruz, Yucatán, to Petén, Guatemala and Eastern Honduras).

This subspecies is represented in the collection by the following specimens: No. 4618, Acultzingo, Veracruz, elevation 6,000 feet, E. H. Taylor, collector, 1932; 4620, Hda. Paso del Rio, Colima, H. M. Smith, collector, 1936; 11616, Pital, Campeche, and 11617, Encarnacion, Campeche, H. M. Smith, collector, 1936. I have also examined a specimen in the collection of the University of Kansas, No. 8486, from an unknown locality (collected in Pocatello, Idaho, by Wayne Whitlow from a bunch of bananas), and a series of specimens in the United States National Museum.

This elongate, slender species is characterized by the large number

of small dorsal blotches on the body with a more or less distinct series of small lateral spots alternating with the dorsal spots; a black bar on the nape not connecting with the first dorsal blotch; a dim, dark bar behind eye, not connecting with the first dorsal bar; three preoculars (preoculars and suboculars); the high ventral count is characteristic of the species (198-211 ventrals; 80 to 102 subcaudals [according to Dunn, 1936, 193-211, 75-102]. I suspect the lower counts are from U. S. N. M. 25206-7, 25209-11, from Tuxpan, which I refer to *L. septentrionalis*).

The body is more or less compressed in all the specimens, but in the Colima specimen it is especially compressed, leaving a sharp dorsal ridge evident. This does not appear to be due to emaciation. This character is absent in the other specimens. In all there is some distribution of fine pigment on the ventrals, especially on the posterior half of the body. It is more dense under the tail. The top of the head is pigmented more or less uniformly, but there is no definite pattern.

The ground coloration of the Veracruz and Campeche specimens is a light brown, sometimes flesh or pinkish brown; ventral surface flesh color. The Colima specimen is gray, the ventral coloration being nearly white. The first dark nuchal blotch is V-shaped or U-shaped, usually not more than two or three scales wide on dorsal line.

The following table gives variational data, presented by the specimens:

Table of data for *Leptodeira annulata polysticta* Günther

Number	4620	4618	11617	11616	8486
Sex or age	♂	yg.	yg.	yg.	♀
Scale formula	25–21–*23*–17	26–23–*23*–17	26–21–*23*–17	26–21–*23*–17	26–21–*23*–17
Ventrals	209	198	208	205	203
Subcaudals	80	84	86	83	90
Upper labials	8–8	8–8	8–8	8–8	8–8
Lower labials	10–10	10–11	10–10	10–11	10–10
Preoculars	3–3	3–3	3–3	3–3	3–3
Postoculars	2–2	2–2	2–2	2–2	2–2
Temporals	1+2+3	1+2+3 1+2+4	1+2+3	1+2+3	1+2+3
Total length (mm.)	845	340	347	437	878
Tail length (mm.)	186	76	78	97	205
Spots, body	60	45	52	57	56
Spots, tail	29	22	24	23	25

A series of specimens in the United States National Museum from Veracruz (7088, 30207, 30208, Orizaba, Sumichrast, collector; and 65154, hills West of Veracruz, Sartorius, collector; 30508, Veracruz, Sumichrast, collector) together with my specimen from Acultzingo, Veracruz, differ from the western Mexican specimen from Colima in having the dorsal spots number only 38 to 54 instead of 60. Two of these have only 2 preoculars, the small lower preocular being absent. The specimens from British Honduras, USNM No. 26058, Tela, Honduras, USNM 64683, and my specimens listed from Campeche have the dorsal spots varying between 52 and 57.

Since I discern no significant differences in squamation or general color characteristics in these specimens, I shall await more material before considering the possibility of separating the eastern and western Mexican forms.

Leptodeira frenata (Cope)

Sibon frenatum Cope in Ferrari-Perez, Proc. U. S. Nat. Mus., 9, 1886 (1887), p. 184 (type description, type locality, Jalapa, Mexico).

Leptodeira annulata personata (*part.*), Amaral, Mem. Inst. Butantan, IV, 1929, p. 204.

Leptodeira frenata Dunn, Proc. Nat. Acad. Sci., 22, 1936, pp. 692, 696.

This form has not been rediscovered, and the type is lost. The original description follows:

"Scales in twenty-three longitudinal series. Body rather slender, tail rather short, head very distinct and depressed. Superior labials nine, eye resting on the fourth and fifth, and only separated from the third by the small inferior preocular. All are higher than long, excepting the eighth and ninth, which are longer than high; the sixth and seventh are the largest. Inferior labials, eleven. Postgeneials much longer than the pregeneials. Loreal plate subquadrate; oculars, 2-2; the superior anterior not reaching the frontal plate. Temporals, 1 + 2 + 3. Frontal twice as long as wide, with parallel sides. Occipitals moderate, reaching to above middle of eighth superior labials. Gastrosteges, 188; anals, 1-1; urosteges, 69.

"*Colors:* Above black, below white. At distance of from six to nine scales, narrow cross-bands of one scale in width rise from the abdominal border color, and meet or terminate in alternating positions on or near the middle line of the back. These bands are more or less gray, sometimes darker in the middle. The top of the head is gray, densely mottled with blackish, leaving a crescentic space of light gray between a black spot behind the head-shields and the beginning of the black of the superior surfaces. A broad, black band passes downwards and posteriorly from the eye, and crossing the angle of the mouth, covers the side of the neck and unites with the black of the following regions. The superior labials are light gray, with black borders. The dark borders of the inferior labials are less distinct.

"Total length, 305 mm.; of tail, 66 mm.; of head to canthus oris, 11 mm. No. 298 [of the Comision Geografica Exploradora de Mexico collection exhibited at the New Orleans Exposition] Jalapa, Mexico.

"This species is nearest the *S. personatum* Cope from Mazatlán, although the coloration is very different. That species had but one preocular, eight superior labials, etc."—E. D. Cope.

There is a possibility that the type of this species was returned to Mexico and it may be rediscovered there. There is no evidence that it was entered in any eastern museum. Cope studied the specimens at New Orleans according to a statement (*loc. cit.*) of Ferrari-Perez (p. 182).

Leptodeira smithi sp. nov.

(Plate XXXI, fig. 2)

Type. EHT-HMS No. 5187. Collected Hda. El Sabino, 19 miles south of Uruapan, Michoacán, México, August 2, 1936. Hobart Muir Smith, collector.

Paratypes. EHT-HMS No. 4633, July 21-28, 1935; No. 5186, July 21, 1936, and No. 5188, August 2, 1936, all collected by Hobart M. Smith at Hda. El Sabino, Michoacán; FMNH No. 985, Balsas, Guerrero, S. E. Meek, collector.

Diagnosis. Fangs grooved; body with 12-15 dark bands, at least double the width of the intervening light spaces; no nuchal line; body not, or but slightly compressed, lacking all trace of keels in

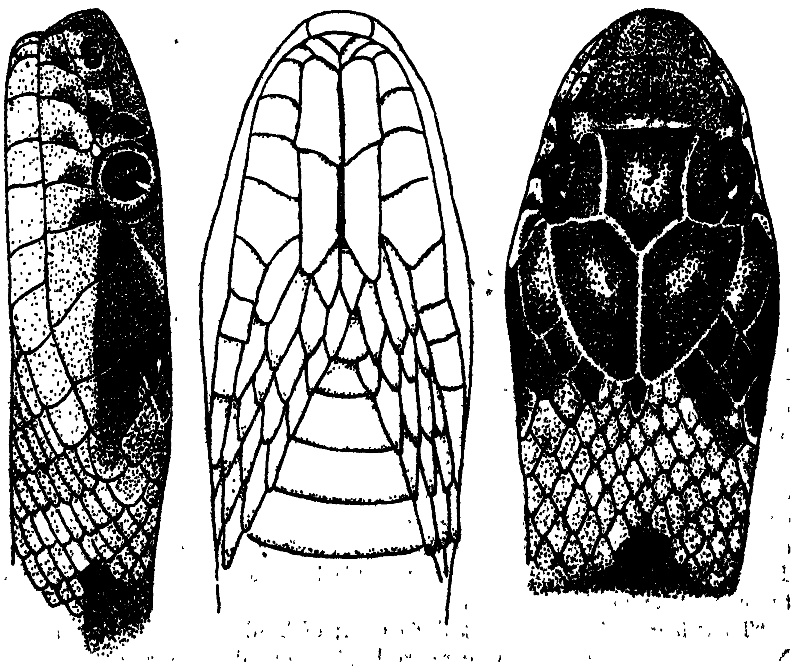

FIG. 5. *Leptodeira smithi* sp. nov. Type EHT-HMS, No. 5187. Hda. El Sabino, Uruapan, Michoacán, México (enlarged).

males and females; 23 (or 21) scale rows; ventrals ♂, 167-168; ♀, 169-173; caudals ♂, 77-79, ♀, 70; preoculars, 2; postoculars, 2; temporals, 1 + 2 + 3; upper labials, 8; lower labials, 10.

Description of the type. Head rather flattened, distinct from neck; rostral not or scarcely visible above, 3.2 mm. wide by 2 mm. high; internasals about as long as broad, their length along median suture, 2 mm.; prefrontals slightly wider than long, 3 × 3.2 mm.; frontal a little shorter than its distance from end of snout, widest anteriorly, the sides not parallel; trace of a groove in the middle line of frontal, with a small regular depression (roughly arrow shaped) at the posterior end of the groove; parietals 6.4 mm. × 4.2 mm., touching only upper postocular; median scale, following median parietal suture only slightly enlarged; nasal large, at least partially divided, the nostril near the middle of the scale, the posterior moiety larger than the anterior; loreal large, longer than high, the lower border much longer than upper; upper preocular very large, irregular, touching the frontal above and the third labial below; lower preocular (subocular) small, square, separating the third labial from the eye; supraoculars wider posteriorly than anteriorly; a large anterior temporal touching both postoculars, followed by two, the upper the larger; these followed by three temporals, the lower of the three extending half its length behind the eighth labial; eight upper labials; fourth and fifth form lower edge of orbit, arranged in the following ascending order of size: 1, 3, 4, 2, 5, 8, 6, 7. The scale following the last upper and lower labials is enlarged; mental small, nearly an equilateral triangle; lower labials ten, five touching the anterior chinshields; the latter scales equally as long and somewhat larger than posterior; two pairs of scales between second chinshields and the first ventral; five rows of scales between the last lower labial and the third ventral; scale formula, 25, 19, 23, 17; ventrals, 169; anal divided; caudals, 70. Total length, 510 mm.; tail, 115 mm.; proportion of tail to body length, .22.

Color. Ground color dirty brownish, the lateral scales of the ground color being edged with blackish, while those on the dorsal part are clear light brown, almost lacking black pigment. Head above blackish or blackish brown, with a trace of whitish bordering most of the head scales, and slightly lighter areas on frontal and parietals; temporal scales usually light-edged, with dark centers; two or three labials with dim dark spots in center; upper edge of posterior upper labials crossed by a dark bar from eye, which terminates on the eighth labial; first light band on occiput about four and

one half scale-rows wide; first black band largest, 15 scale-lengths wide; succeeding bands vary from a width of 10 scales to 8 scales; the smaller bands are more posterior. Ventral surface immaculate, save for a peppering of pigment on the anterior part of chin and a few flecks under posterior part of tail. The bands reach laterally and cover part of the scales of the first row.

Table of Measurements in mm. and data of *Leptodeira smithi* sp. nov.

Number	4633	5186	5187	5188
Sex	♂	♂	♀	♀
Ventrals	167	169	169	173
Subcaudals	79	77	70	?
Preoculars	2-2	2-2	2-2	2-2
Postoculars	2-2	2-2	2-2	2-2
Temporals	1+2+3	1+2+3	1+2+3	1+2+3
Scale formula	21-23-17	21-21-15	(19-21)-23-17	20-23-17
Length, total	262	408	510	434
Length, tail	68	97	115	22 (broken)
Spots, body	14	12	14	15
Spots, tail	7	8	7	7

Variation. Outside of variations listed in the table, the specimens are remarkably uniform in squamation and likewise in color and markings. Neither males or females show any trace of keels on the dorsal scales above the anal region. Variation in proportion of tail to body length varies from twenty-five percent in a young male to twenty-one percent in a female.

Relationship. I believe this form is a derivative of *L. maculata* rather than *L. mystacina,* which it superficially resembles in the broad dorsal markings. The light edging of the scales on the head, characteristic of *L. maculata,* is in evidence in this species. The species is dedicated to Dr. Hobart M. Smith, its discoverer, in recognition of his extensive herpetological exploration in Mexico.

A single specimen of this species (No. 985 Balsas, Guerrero) present in the collection of the Field Museum of Natural History, Chicago, has been made available to me due to the characteristic kindness of Dr. Karl P. Schmidt. This specimen is typical. Ventrals, 166; subcaudals, 68; preoculars and postoculars, 2-2; spots on body, 15; on tail, 6. The head is generally dark with the characteristic light edges on the dorsal scales.

Leptodeira maculata (Hallowell)

(Plate XXXI, fig. 1; Pl. XXXII, figs. 1-4; Pl. XXXIII, figs. 1-3)

§ *Dipsas annulata* var. C, Duméril and Bibron, Erp. Gén. VII, 1854, p. 1141 (two specimens from Mexico).

Leptodeira annulata (*part.*) Günther, Cat. Col. Snakes British Museum, 1858, p. 166 (certain Mexican specimens).

Sibon annulata (*part.*) Cope, Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 266 (Mexican specimens from Jalapa).

Megalops maculatus Hallowell, Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 488 (type description; type locality, "Tahiti"; probably Nicaragua [*fide* Dunn, 1936]).

Leptodeira personata Cope, Proc. Acad. Nat. Sci. Philadelphia, 1868 (1869), p. 310 (type description; type locality, Mazatlán, Sinaloa, Mexico); Günther, Biologia Centrali-Americana, Reptilia and Batrachia, May, 1895, p. 171, pl. LIV, figs. A and B (Presidio, and Mazatlán, Sinaloa; Santo Domingo de Guzman and Hda. Santa Gertrudis, Jalisco; Mexico City; Jalapa, Veracruz); Boulenger, Cat. Snakes British Mus., III, 1896, pp. 93-94 (Southern Mexico and Guatemala, several localities); Mocquard, Mission Scientifique au Mexique Rept., livr. 16, 1908, pp. 903-904.

Eteirodipsas annulata, var. *septentrionalis* Jan, Icon. Gén., 39, 1872, pl. 1, fig. 2.

Sibon personatum Cope, Bull. U. S. Nat. Mus., No. 32, 1887, p. 67; Proc. U. S. Nat. Mus., XIV, 1892, p. 677; Ann. Rep. U. S. Nat. Mus., 1898 (1900), p. 1107.

Leptodeira albofusca Stejneger, Proc. U. S. Nat. Mus., 69, 1926, pp. 2-3 (refers *Megalops maculatus* Hallowell to this species).

Leptodeira annulata annulata (*part.*) Amaral, Mem. Inst. Butantan, IV, 1929 (includes *Megalops maculatus* as a synonym of this form).

Leptodeira septentrionalis maculata Dunn, Proc. Nat. Acad. Sci., XXII, 1936, pp. 692, 697 (Cape San Lucas, Baja California; Mazatlán, Sinaloa; Zacualtipan, Hidalgo; Tuxpan, Veracruz, "Tepanatepec" and "Zamtepec," Oaxaca [?] Nicaragua and Costa Rica).

The type of *Megalops maculatus* Hallowell was supposed by Hallowell to have been collected in Tahiti by Mr. Adams of the Rogers Exploring Expedition. The type specimen, subsequent to its study by Hallowell at Philadelphia, in 1860, was returned to the National Museum at Washington and there apparently was lost or mislaid until rediscovered by Dr. Leonhard Stejneger in 1926. After an examination of the specimen, Doctor Stejneger identified it as belonging to the genus *Leptodeira* and the species *Leptodeira albofusca* Lacépède as interpreted by Boulenger, Cat. *op. cit.* p. 95. Dunn (*loc. cit.*), however, regarded it as being identical with Cope's species *Leptodeira personata*.

I examined this type specimen in Washington (USNM 7367). It is in a fair state of preservation, but a serious injury to the head makes it difficult to determine the exact characters of many of the dorsal head scales.

The following characters can be discerned. The single preocular is well separated from the frontal, and has a curved rather than an angular front edge; the prefrontals are fused for more than half their length, and are double the length of the internasals; loreal elongate, much longer than high; apparently only one postocular; fourth and fifth labials enter eye; first light band six scales long;

no nape stripe; twenty dark bars across body; 9 + bands on the tail; ventrals, 171; tail tip missing; the spots tend to break, and are irregular; the contrast between the dark spots and light interspaces is very pronounced; head markings indiscernible save that the frontal appears a little darker than other dorsal head scales, and the edges are somewhat lighter.

The scale formula, 19, 21, 21, 17, differs from the usual formula as shown in the table.

Both Dunn and Stejneger regard it probable that this specimen originated in Nicaragua. Dunn states that aside from six specimens in the Museo Nacional de Costa Rica, no others are known south of Tehuantepec.

I believe that the identity of this form with *L. personata* is still open to question. Dunn advises me that data was not taken by him on the specimens in Costa Rica, and that he does not doubt that they originated in Costa Rica despite the lack of specific locality data. It may be that the type of *Megalops maculata* is conspecific with *L. dunckeri,* since they agree in certain characters in which both differ from Mexican forms considered here under the name of *maculata.* This can only be settled by a series of specimens from Nicaragua and Costa Rica. While I am here following Dunn in placing *Leptodeira personata* as a synonym of *Leptodeira maculata,* I feel that this disposition should not be regarded as final until the form *L. maculata* is rediscovered in Nicaragua and Costa Rica, and scale data taken to prove that the apparent differences, in pre- and postoculars, and the reduced scale formulae are not sufficiently constant to warrant its separation from *L. personata.*

Forty-five specimens in the collection have been referred to this species. These are as follows: Nos. 5175, 5174, km. 609, Mexico-Laredo Highway, a few miles north of Limon, June, 1936, E. H. Taylor, collector; 4638-4640, Hda. La Clementina, Tamaulipas, David Dunkle and H. M. Smith, collectors; 4631, five miles east of Jalapa, Veracruz; 4632, 4635, 4637, four miles east of Encero, Veracruz, July 14, 1932, and 4636, Tierra, Colorada, Veracruz, July 16, 1932, collected by H. M. Smith and E. H. Taylor; 5176, 15 miles west of Veracruz, August 31, 1936, E. H. Taylor, collector; 4624-4626, near Totolapam, Oaxaca, August 6, 1935, H. M. Smith, collector; 4643, 4644, 4651, near San Ricardo, Chiapas, September 2, 1935, and 4642, 4647-4650, near Asunción, Chiapas, September 1, 1935, E. H. Taylor and H. M. Smith, collectors; 4656-4657, Presidio, Mazatlán, Sinaloa, July 19, and July 23, 1934, E. H. Taylor, collector; 4621-4623, 4641,

Hda. Paso del Rio, Colima, H. M. Smith, collector; 4645-4646, uncertain Mexican locality (probably Puente Nacional, Veracruz).

Aside from the above 30 specimens are 15 specimens from Guerrero as follows: No. 4653 Mazatlán, 1400 meters, 5180 Agua del Obispo 1000 m., 5182 Dos Caminos, 615 m., 4627, 4627 A, 4634, 4654 Garrapatas, 520 m., collected by E. H. Taylor and H. M. Smith, June, 1932; Nos. 5183, 5183 A, 5184, 5185, 200 m., E. H. Taylor, August 1, 1936; Nos. 4629, 4655, 4628, 4630, one mile north Organos, E. H. Taylor and H. M. Smith.

These Guerrero specimens are tentatively referred to the form *Leptodeira maculata*. They form two color varieties which agree very largely in their squamation, save that one seems to have a higher average of scale rows. In both, males show traces of keels above anal region.

The figures (plate XXXI, fig. 1, a young specimen from Tamaulipas, No. 4638; plate XXXII, fig. 1, adult, No. 4628, near Organos, Guerrero; fig. 2, adult, No. 4653, near Mazatlán, Guerrero; fig. 3, adult, No. 4643, San Ricardo, Chiapas; fig. 4, adult, No. 4624, Totolapam, Oaxaca) given herewith show a remarkable variation in the color and markings. Certain of these are especially striking, particularly the Guerrero specimen (No. 4628) which occurs together in at least two localities with the form represented by plate XXXII, fig. 2. The differences are not due to elevation, age or sex.

The species is apparently absent on the plateau proper, but may reach some elevation along the edges of the plateau. In the Sierra Madre of Guerrero the highest elevation was 1,400 meters; in Oaxaca probably less than 1,000 meters.

Certain of the differences in coloration are accompanied by certain scale differences, and differences in proportion of body to tail, as may be shown by the following tabulation.

A. Tamaulipas specimens. Tail, 15 to 18 percent of total length; body spots, 25 to 28, often confluent; tail spots, 9 to 13; body spots reach to first scale row (plate XXXI, fig. 1).

B. Guerrero (form with general darkened coloration tending to obscure spots). Tail, 19 percent of total length (♀); body spots, 31 to 38; 15 spots on tail; body spots reach 4th to 6th scale rows. Three of eight specimens with 25 scale rows about body, instead of 23 rows (plate XXXII, fig. 1).

C. Guerrero (form with spots distinct). Tail, 23 percent of total length (♂); 29 to 37 spots on body; tail spots, 15+; body spots extend to 4th scale row (plate XXXII, fig. 2).

D. Chiapas specimens. Tail, 21 to 22 percent of total length; body spots, 28 to 30; tail spots, 10 to 14; body spots reach 1st to 4th scale rows; intercalated spots (plate XXXII, fig. 3).

E. Oaxaca specimens. Tail, 21 to 22 percent of total length. 25 to 29 spots on body; 15 to 18 on tail; body spots to fourth row (plate XXXII, fig. 4).

F. Sinaloa and Colima specimens. Tail (young), 21.8 percent total length; spots on body, 22 to 27; on tail, 8 to 10; body spots reach to the first or second row.

With an accumulation of large series from widespread localities it appears likely that it will be possible to define certain of these forms clearly enough to warrant subspecific designations.

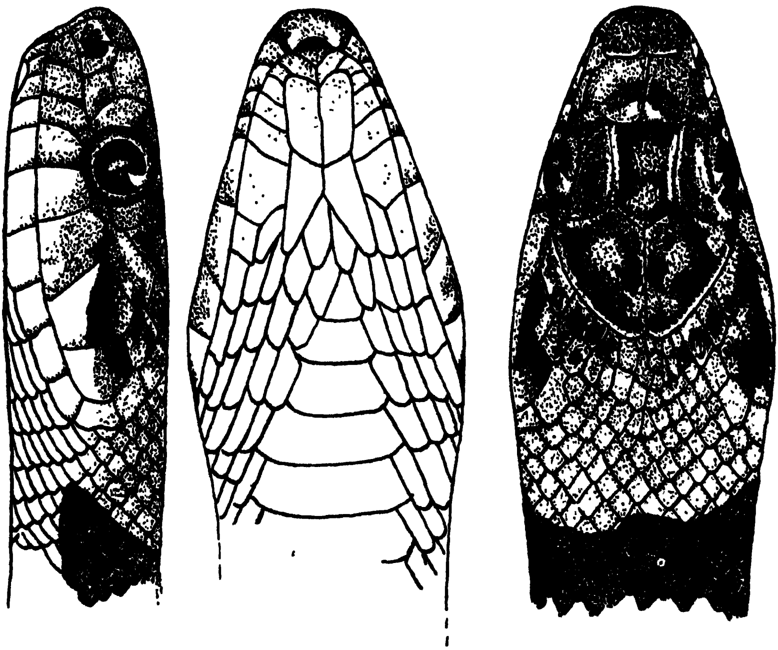

FIG. 6. *Leptodeira maculata* (Hallowell). EHT-HMS, No. 4624. Near Totolapam, Oaxaca, México (enlarged).

The preoculars and postoculars are invariably 2-2, save in Nos. 5180 and 4642, in which the right lower scale is fused with the labial. The postoculars are invariably two. The upper labials are 8-8 invariably; the lower labials 10-10, save that two specimens have 9 on one side, only, and one has 11 on both sides. The relation of the upper preocular to the frontal varies; in northeastern (Tamaulipas) specimens they are invariably in contact; the same is true in all Chiapas specimens; of those from Veracruz, three specimens have them separated; one in contact on both sides, and another in contact on one side only. Specimens from Sinaloa and Colima are variable in this regard, some having them in contact, some separated,

some variable on the two sides of the head. In Guerrero specimens, ten have them touching, three have them separated. The temporal formula is $1 + 2 + 3$. Five specimens have this varied by fusion or by the splitting of a scale in the last series. One has the first temporal divided vertically.

The typical juvenile coloration of the species is cream, with blackish bars, wider on the dorsum than on the sides. The adults

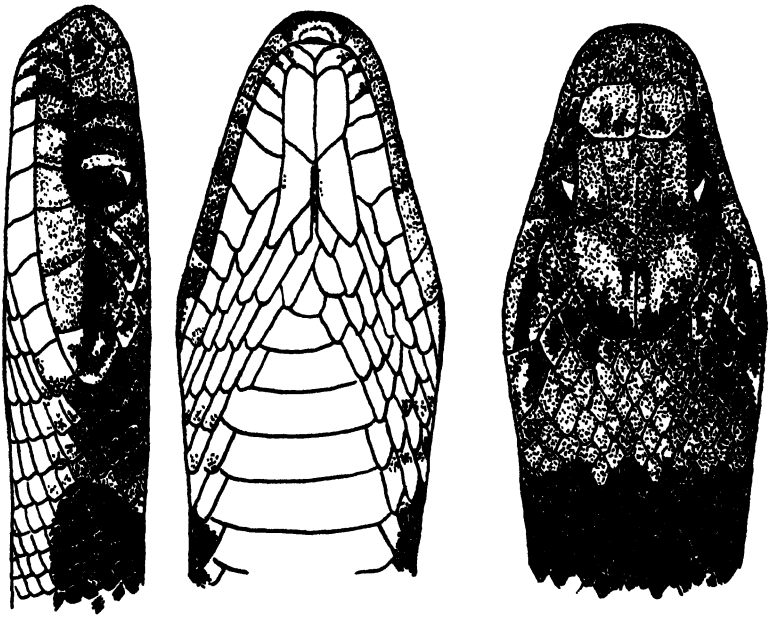

FIG. 7. *Leptodeira maculata* (Hallowell). EHT-HMS, No. 4628. One mile north of Organos, Guerrero, México (enlarged).

have the black less intense, many, if not all, the black scales showing numerous grayish flecks. The ground color becomes covered with darker pigment of a grayish-brown color, which is usually more intense on the outer parts of the scales. The coloration is less intense along the borders of the dark spots and along the back. In general, too, the head is dark, with light edges on the dorsal head scales. One specimen from Chiapas (No. 4649) has a nuchal bar, thus approaching the condition in *rhombifera*.

Three specimens from Oaxaca (4624-4626) and three from Chiapas 4644, 4648, 4651, have the dorsal spots reaching only to the fourth lateral row. These likewise appear to have a greater number of tail spots and a somewhat higher average of subcaudals.

The darker coloration of certain Guerrero specimens (plate XXXII, fig. 1) is evident in the young specimens (Nos. 5182-5185). (plate XXXIII, fig. 2.)

The table given herewith shows further variations in squamation and proportions.

Table of data on *Leptodeira maculata* (Hallowell)

NUMBER.	Sex or age.	Scale formula.	Ventrals.	Subcaudals.	Spots, body.	Spots, tail.	Total length.	Tail.
5175	♀	21-23-17	171	59	26	9	677	120
5174	♂	21-23-17	172	55	27	8	432	77
4638	yg.	21-23-17	169	60	26	10	275	53
4639	♂	21-23-17	171	55	26	9	555	104
4640	♀	21-23-17	172	59	27	9	555	104
4631	♀	21-23-17	177	66	28	13	594	115
4632	♂	21-23-16	178	.	26	10	398*	.....
4635	♂	21-23-17	174	68	26	10	527	101
4637	♀	21-23-17	179	65	25	9	490	97
4636	♀	21-23-17	179		27	11	276*	......
5176	♀	23-25-17	177	...	25	......	502*	.....
4624	♀	21-23-16	172	69	29	13†	405	88
4625	♂	21-23-17	171	75	29	15†	547	121
4626	♂	21-23-17	169	76	25	18†	529	115
4643	♂	21-23-17	177	62	29	11	666	131
4647	♂	21-23-17	178	64	30	9	492	83
4642	♂	21-23-17	177	66	30	11	485	94
4650	♀	21-23-17	170	65	29	11	495	105
4648	♂	21-23-16	172	71	28	14†	507	107
4649	♂	21-23-17	174	...	29	8†	400*	...
4644	♀	21-23-16	171	70	30	11	437	97
4651	yg.	21-23-17	174	71	30	12†	371	85
4656	yg.	19-23-17	164	70	24	8	275	60
4657	yg.	21-23-17	170	68	27	10	255	56
4621	♂	21-23-17	173	..	21	4†	392*	..
4623	♀	21-23-17	169	70	21	9	309	66
4622	♂	21-23-17	172	73	24	14†	530	122
4641	♀	21-23-17	170	71	21	10	537	118
4645	♀	21-23-17	167	70	24	11	630	135
4646	♀	21-23-17	170	64	25	10	740	146
4654	♀	21-23-17	176	71	37	15†	487	100
4634	♀	21-23-17	178	70	34	13†	694	137
4627	♂	19-21-15	175	84	33	21	592	140
4627A	♂	21-23-17	176	..	32	13	450*	..
4629	♂	21-23-17	175	80	34	14†	580	137
4655	yg.	21-23-17	174	71+	32	13†	328	73+
4653	♀	21-23-15	175	73	29	18†	287	67
4628	♀	23-25-17	173	67+	34	..	673	132+
4630	♀	23-25-17	178	68+	38	..	715	137+
5185	♀	21-25-17	176	69	37	17†	308	66
5182	♀	21-23-17	176	71	31	15†	308	67
5184	♂	21-23-16	174	77	30	18†	272	65
5180	♂	21-23-16	175	76	33	21	231	57
5183	♀	21-23-17	175	75	35	18†	230	52
5183A	♀	21-23-17	174	75	34	17†	222	41+

* To vent only. † Obscured posteriorly.

Pseudoleptodeira gen. nov.

Genotype. Hypsiglena latifasciata Günther=*Leptodeira guilleni* Boulenger.

Scales in 19-21 rows; head rather broad, the snout not protruding noticeably beyond mouth; nasal divided; loreal present; pupil vertical; anal divided; scales smooth with paired apical pits; two pairs of chinshields; tail relatively long, the subcaudals in two rows, exceeding 60; maxillary teeth about 13-13, increasing in length backward and followed after a short interspace by a large fang, lacking trace of groove.

Hypsiglena discolor Günther is tentatively referred to this genus.

Pseudoleptodeira latifasciata (Günther)

(Plate XXXI, fig. 4)

1894. *Hypsiglena latifasciata* Günther, Biologia Centrali-Americana. Rept. Batr., Oct., 1894, p. 138, pl. XLIX, fig. B (type description; type locality, southern México); Boulenger, Cat. Snakes British Mus., II, 1894, p. 211; Mocquard, Mission Scientifique au Mexique et dans l'Amérique Centrale, Rept., livr. 16, 1908, p. 870; Dunn, Proc. Nat. Acad. Sci., 22, No. 12, Dec., 1936, pp. 696-697 (unites *H. latifasciata* and *Leptodeira guilleni*).

1905. *Leptodeira guilleni* Boulenger, Proc. Zool. Soc. London, June 6, 1905, p. 247, pl. VII, fig. 2 (type description: type locality, Rio Balsas, Guerrero. Hans Gadow, collector); Mocquard, Mission Scientifique au Mexique et dans l'Amérique Centrale, livr. 16, 1908, p. 903 (description from Boulenger).

The two specimens in the collection are No. 5189, from a point about 3½ miles southeast of El Naranjo, Guerrero, México (near km. 190), July 18, 1936, E. H. Taylor, collector; and 4658, from Hda. El Sabino, Michoacán, México, Hobart Smith, collector.

The latter is the smaller specimen, but it agrees in striking manner with the general markings and shade of coloration of the larger specimen. The following scale and other data are from Nos. 4658, and 5189, respectively: Scale formula, 25, 21, 21, 17; 26, 21, 23, 17; ventrals, 188, 191; subcaudals, 80, 69; anal, 2, 2; preoculars, 2, 2; postoculars, 2, 2; temporals, 1 + 2 + 3 (1+2+4); 1+2+3; nasal divided; upper labials, 8, 8; lower labials, 10, 10; posterior chinshields much the longest in both; maxillary teeth, 13, 13; ptergoid teeth, 30, 31; black bands on body, 8, 8; on tail, 3, 3.

Smith's field book gives the following data on No. 4658: "Very large black blotches—has the parietal region of the head and the nape of the neck brick red. It was found in one of the rooms of the house at night hunting geckoes." My field book records the following for No. 5189. "Occipital region red-orange, the light line on lip flesh; light bands on body edged with yellow and on the median dorsal region this yellow color is also faintly visible; the remainder

of the light blotches or bands are grayish-white. The black bands are darkest along the median line, while the sides show some grayish color which is washed with dim yellow; ventrals with much pigment, the edge and the median part of the scale being the only part which lacks pigment. The lighter color of the venter is dull cream-yellow. The ventrals have a strong iridescence. Taken in a mass of rotten sandstone under a vertically placed slab."

The dim nuchal line is present from parietal almost to the first narrow bar of black. The major part of the parietals is red-orange; the light line behind eye is strongly defined; the dark line above connects with the first black nuchal bar; anterior labials and lower labials with small blotches of pigment.

A recent communication from Mr. H. W. Parker, of the British Museum, assures me that the type of *Leptodeira guilleni* Boulenger does not have grooves on the fangs and is unquestionably conspecific with *Hypsiglena latifasciata* Günther.

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1913. WERNER, FRANZ. Neue oder seltene Reptilien und Frösche des Naturhistorischen Museums in Hamburg. Mitt. Nat. Mus. Hamburg, 1913, 30, pp. 1-49.

PLATE EXPLANATIONS

PLATE XXX

FIG. 1. *Leptodeira punctata* (Peters). EHT, No. 4614, Mazatlán, Sinaloa.

FIG. 2. *Leptodeira splendida* Günther. EHT, No. 5177, 12 miles south, Puente de Ixtla, Morelos.

FIG. 3. *Leptodeira annulata polysticta* Günther. EHT-HMS, No. 4620, Hda. Paso del Rio, Colima.

FIG. 4. *Pseudoleptodeira latifasciata* (Günther). EHT-HMS, No. 5189, 3½ miles southeast El Naranjo, Guerrero.

PLATE XXX

PLATE XXXI

FIG. 1. *Leptodeira maculata* (Hallowell). EHT-HMS, No. 4638 (young), Hda. La Clementina, near Forlon, Tamaulipas.

FIG. 2. *Leptodeira smithi* sp. nov. EHT-HMS, No. 5186 (paratype), Hda. El Sabino, near Uruapan, Michoacán.

FIG. 3. *Leptodeira septentrionalis* (Kennicott). EHT-HMS, No. 4616, Hda. La Clementina, Tamaulipas.

FIG. 4. *Leptodeira bressoni* sp. nov. EHT-HMS, No. 5172 (type), Hda. El Sabino, 20 miles south, Uruapan, Michoacán.

PLATE XXXI

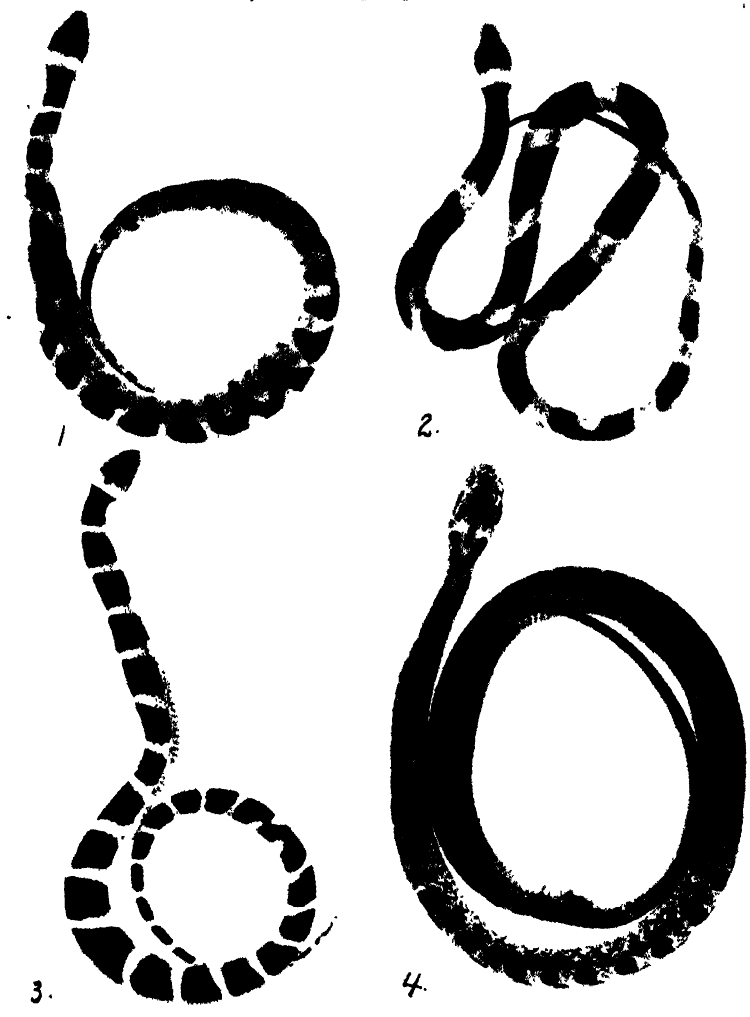


PLATE XXXII

FIG. 1. *Leptodeira maculata* (Hallowell). EHT-HMS, No. 4628, one mile north Organos, Guerrero.

FIG. 2. *Leptodeira maculata* (Hallowell). EHT-HMS, No. 4653, near Mazatlán, Guerrero.

FIG. 3. *Leptodeira maculata* (Hallowell). EHT-HMS, No. 4643, San Ricardo, Chiapas.

FIG. 4. *Leptodeira maculata* (Hallowell). EHT-HMS, No. 4624, Totolapam, Oaxaca.

PLATE XXXII

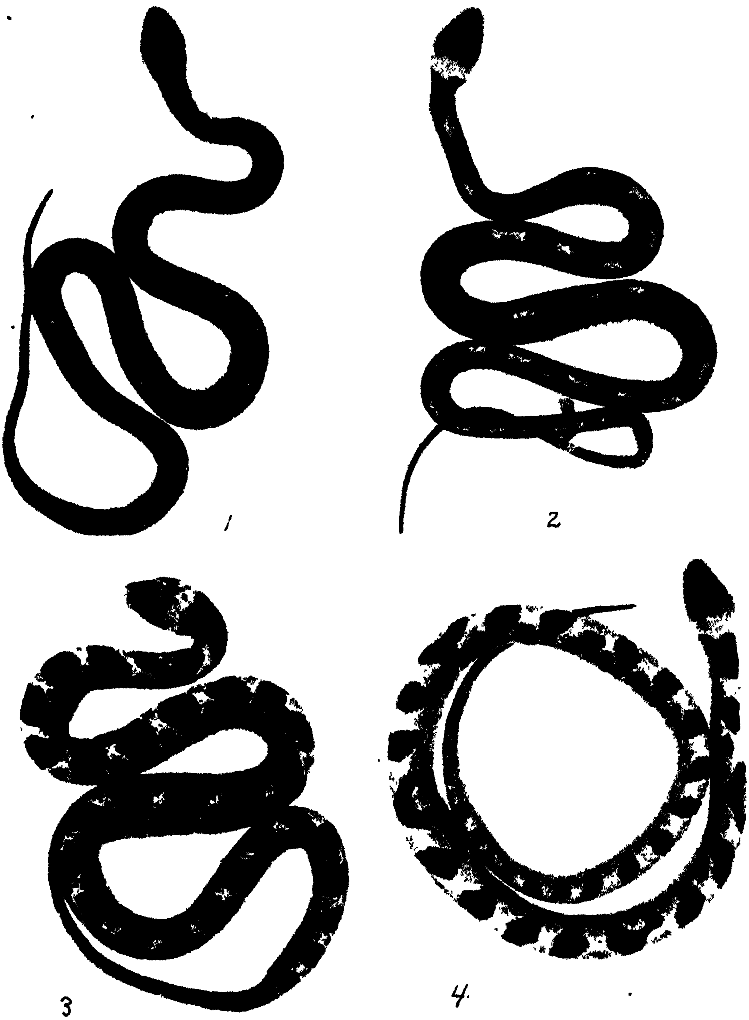


PLATE XXXIII

FIG. 1. *Leptodeira maculata* (Hallowell). EHT-HMS, No. 4653, Mazatlán, Guerrero (young).

FIG. 2. *Leptodeira maculata* (Hallowell). EHT-HMS, No. 5182, Dos Caminos, Guerrero (young).

FIG. 3, 3a. *Leptodeira maculata* (Hallowell). MCZ, No. 11420, Colima, México.

FIG. 4. *Leptodeira bressoni* sp. nov. MCZ, 11411, (♀) Colima.

PLATE XXXIII

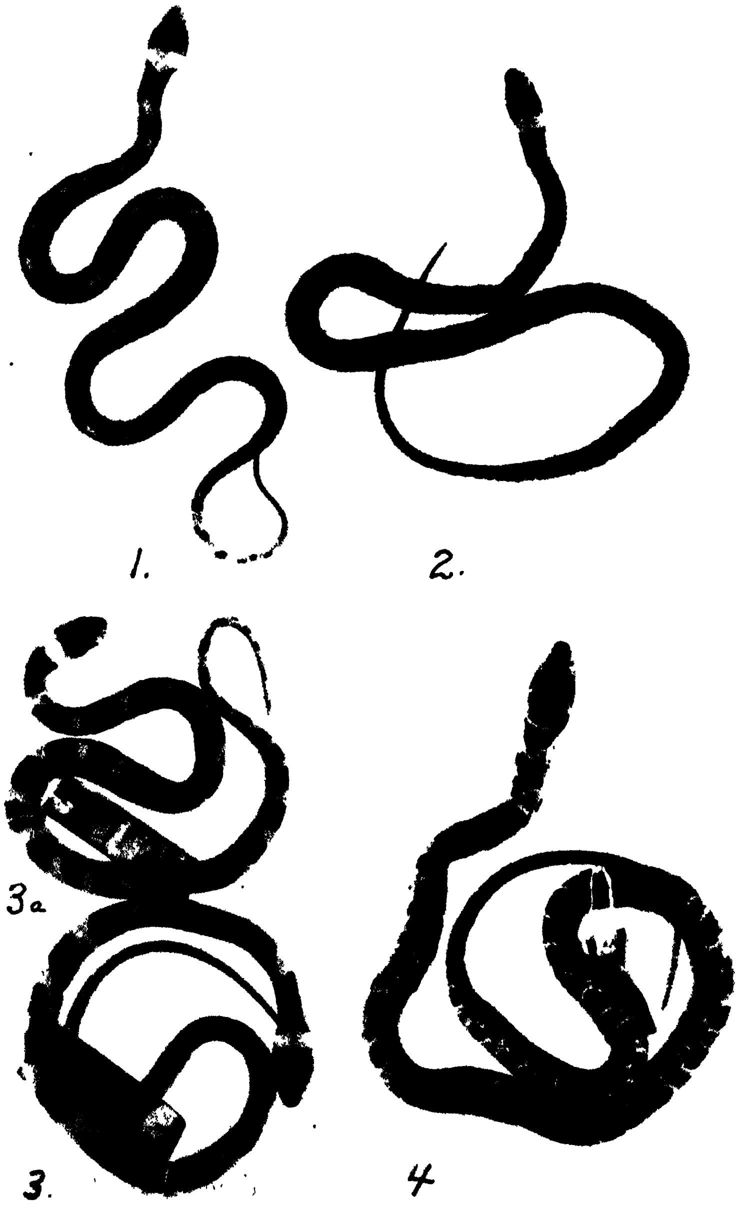


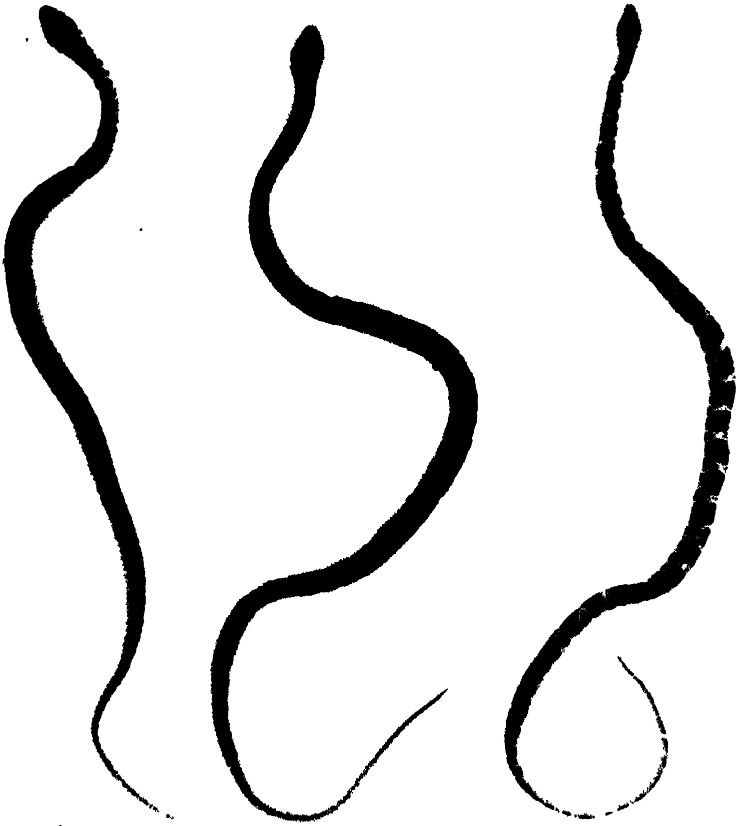
PLATE XXXIV

FIG. 1. *Leptodeira bressoni* sp. nov. EHT-HMS, No. 4619 (young), near Queseria, Colima.

FIG. 2. *Leptodeira annulata polysticta* Günther (young). EHT-HMS, No. 4618, Acultzingo, Veracruz.

FIG. 3. *Leptodeira yucatanensis mallerisi* Dunn and Stuart. EHT-HMS, No. 11618 (♂), Encarnacion, Campeche.

PLATE XXXIV



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THE UNIVERSITY OF KANSAS
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VOL. XXV] JUNE 1, 1938 [No. 16

On Mexican Snakes of the Genera Trimorphodon and Hypsiglena

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(Plates XXXV-XXXIII, Text fig. 7)

ABSTRACT: This study is based on specimens collected in Mexico by Edward H. Taylor and Hobart M. Smith. The following species of *Trimorphodon* are recognized: *Trimorphodon bi-scutatus* Duméril and Bibron: *paucimaculatus* Taylor; *lambda* Cope; *vilkinsonii* Cope; *lyrophanes* (Cope); *vandenburghi* Klauber; *latifascia* Peters; *upsilon* Cope; and *tau* Cope.

Hypsiglena placed in synonymy of *Leptodeira* is again validated, and recognized as distinct on the basis of ungrooved back teeth, single instead of double apical pits, together with reduced vertebral series, and other characters of perhaps lesser importance.

The following forms are recognized: *Hypsiglena torquata torquata* Günther; *torquata dunklei* subsp. nov., Tamaulipas, Mexico; *affinis* Boulenger, and *ochrorhynchus* Cope.

Trimorphodon Cope

Dipsas (part.) Duméril and Bibron, Erp. Gén., VII, 1854, p. 1133 (*D. bi-scutata* Duméril and Bibron).

Dipsadomorphus (*part.*) Günther, Cat. Col. Snakes British Mus., 1858, p. 174 (*D. bi-scutata*, Duméril and Bibron).

Trimorphodon Cope, Proc. Acad. Nat. Sci. Philadelphia, 1861, p. 297 (*lyrophanes* Cope)

Eteirodipsas (*part.*) Jan, Elenco sist. Ofid., 1863, p 105.

Sibon (*part.*) Garman, Mem. Mus. Comp. Zool. Harvard College, VIII, No. 3, p. 16

The group of back-fanged snakes belonging to this genus is characterized by greatly enlarged anterior maxillary teeth followed by smaller teeth which decrease somewhat posteriorly, and are followed after an interspace by a pair of enlarged, grooved fangs; anterior mandibular teeth and, to a lesser extent, the anterior palatine teeth, enlarged; head distinct from neck; two pairs of chinshields, the anterior largest; seven or eight scale rows between first ventrals and posterior lower labial; two loreals present, and frequently a third, which is situated below the posterior; nasal divided, the nostril vertically elongate; pupil elliptic; eye moderate, less than the distance

from nostril; usually three preoculars (two preoculars, one "subocular" and three postoculars); scales smooth (or bluntly keeled in males), slightly oblique, with paired apical pits, in 22-27 rows. Ventrals obtusely angulate; subcaudals divided; anal divided usually (single in *vandenburghi*). Body compressed.

I recognized nine forms, which I have here treated as full species. All save one of these are known to occur in Mexico. This exception, *vandenburghi*, has been taken at the border in the southern part of California and it is safe to state that it likewise occurs in Mexico in northern Baja California.

Four of the species, *T. vandenburghi, lyrophanes, upsilon,* and *biscutatus*, are represented by several specimens in museum collections. The other five forms are still rare. *Trimorphodon tau* is probably still known only from type; *paucimaculatus,* from type only; *lambda,* from three specimens; *vilkinsonii,* from two specimens, and *latifascia,* from three. It is, of course, probable that there are museum specimens of the latter five species that have not been reported in the literature.

Table of data on species of *Trimorphodon*

	Upper labials.	Average ventral-subcaudal total.	Scale rows.	Head markings.
bi-scutatus (a)	9	370 (362 376)	(25 27)-(17-16)	Chevrons.
bi-scutatus (b)	9	338 (333-348)	(25-27)-(17-16)	Chevrons.
paucimaculatus	9	329	25-17	Chevrons.
lambda ..	9	313 (309-317)	(22-23) (16-15)	Chevrons.
vilkinsonii ..	9	308	23-17	3 black spots.
lyrophanes ..	9 (8)	306	(22 23)	Lyre-shaped mark.
vandenburghi	9 (8)	302 (299-304)	(21-23)-15	Lyre-shaped mark.
latifascia	9	293 (290-296)	25-15	Black, with red collar.
upsilon...	8	288 (280-297)	(22-23)-15	Y-shaped mark and yellow collar.
tau	7	....	....	T-shaped mark.

Trimorphodon bi-scutatus (Duméril and Bibron)

(Plate XXV, fig. 1)

Dipsas bi-scutata Duméril and Bibron, Erp. Gén., VII, 1854, p. 1153 (type description; type locality, "Mexique").

Dipsadomorphus biscutatus Günther, Cat. Col. Snakes British Mus., 1858, p. 176 (México); Salvin, Proc. Zoöl. Soc. London, May 25, 1861, p. 228 (San Gerónimo, Vera Paz, Guatemala [27 scale rows]).

Trimorphodon bi-scutatus Cope, Proc. Acad. Nat. Sci. Philadelphia, 1861, p. 297; and Proc. Amer. Philos. Soc., XI, 1869, p. 152; Sumichrast, Arch. Sci. Phys. Natur., 46, 1873, p. 247; and *idem*, pp. 253-255; Dugès, La Naturaleza, VI, 1883(?), pp. 145-148, figs. 3a, 4a,

5a, (Venom); Cope, Proc. Amer. Philos. Soc. XXIII, 1886, p. 286; and Proc. U. S. Nat. Mus., XIV, 1891 (1892), p. 679; Stejneger, Ann. Rept. U. S. Nat. Mus., 1893 (1895), pp. 348, 349; Günther, Biologia Centrali-Americana, Rept. Batr., May 1895, pp. 174-175 (*part.*); Boulenger Cat. Snakes Brit. Mus., 2d Ed., 1896, pp. 54, 55 (*part.*); Cope, Amer. Nat., Dec., 1896, p. 1025; Cope, Ann. Rept. U. S. Nat. Mus., 1898 (1900) p. 1101; Gadow, Proc. Zoöl. Soc. London, 1905, p. 224; Mocquard, Mission Scientifique au Mexique et dans l'Amérique Centrale, Rept., livr. 16, 1908, pp. 908-909; Gadow, Zoöl. Jahrb., Bd. 29, Heft. 6, 1910, p. 699; Werner, Mitt. Nat. Mus. Hamburg, 30, 1913, pp. 29-30; Schmidt, Field Mus. Nat. Hist. Zoöl. Publ., XII, 1928, p. 199; Werner, Zoöl. Jahrb., 57, 1929, p. 181; Amaral, Mem. Inst. Butantan, IV, 1929, p 201.

Eteirodipsas biscutata Jan, Elenco Sist. Ofid., 1863, p. 105.

Trimorphodon major Cope, Proc. Amer. Philos. Soc., XI, 1869, p. 153, and Journ. Acad. Nat. Sci. Philadelphia, (2), VIII, 1876, p. 131; Sumichrast, Arch. Sci. Phys. Natur., 46, 1873, p 247; *idem*, pp. 254-256.

Sibon biscutatum Garman, Mem. Mus. Comp. Zoöl. Harvard College, VIII, No. 3, 1883, pp. 16, 131.

Dipsas biscutata Herrera, Cat. Coll. Rept Batr. Mus. Nac. Mexico, 1904, p. 38 (Guanajuato).

This species is represented in my collection by eight specimens as follows: EHT, Nos. 5338, 5339, Hda. El Sabino, Michoacán, Raymond Bresson, collector, Oct., 1935; 5145-5148, Agua del Obispo, km. 350-357, between Rincón and Cajones, Guerrero, elevation 1,000 m., August 1, 1936, E. H. Taylor, collector; 4588, one mile north of Organos, Guerrero, elevation 200 m., June, 1932, E. H. Taylor, collector; 4589, San Ricardo, Chiapas, September 2, 1935, H. M. Smith, collector.

The series of specimens reported under this name by Boulenger (1896) may very probably include more than one form. I have elsewhere* suggested that the specimens from Mazatlán and Presidio, Sinaloa, may belong to *Trimorphodon paucimaculatus* Taylor.

My series shows two varieties. The two Michoacán specimens have a greatly reduced number of spots on body and tail (14-7, 14-7) as compared with those from Guerrero, which average a total of 32 spots. They agree, however, in the very high ventral and subcaudal counts, the average of the total ventral-subcaudal count being 371. The single specimen from Chiapas, a male, has the ventral count reduced, the total ventral-subcaudal count being 346. In the specimens listed by Boulenger (1896) from Oaxaca, Guatemala (2 specimens), Panama and Central America, the range of the totals is 327 (Oaxaca) to 348 (Panama), the average, with my Chiapas specimen, being 339. Schmidt (*loc. cit.*) reports a specimen from Salvador with a total count of 340.†

Males have the scales of the posterior half or third of the body bluntly keeled, or ridged; they appear more pronounced in the largest specimens, especially above the anal region and on the tail.

* Taylor, Kansas Univ. Sci. Bull. Vol. XXIV, 1937, p. 529.

† This specimen has scale rows, 25-17, ventrals, 255, subcaudals, 85; upper labials, 7-9; lower labials, 13-12, preoculars, 3-3; postoculars, 3-3; temporals, 3-3; length, 878 mm.; tail, 158 mm.; ratio tail to total length, 18.

Werner (1913) reports a specimen 1,545 mm. long, with the scales strongly keeled.

Table of data for *Trimorphodon bi-scutatus*

Number	5145	5146	5147	5148	4588	4589	5338	5339
Sex	♂	♂	♂	♂	♂	♀	♂	♂
Ventrals	275	274	272	272	270	261	269	267
Subcaudals .	101	99	99	102	100	85	101	95
Anal . .	2	2	2	2	2	2	2	2
Supralabials	9–9	9–9	9–9	9–9	9–9	9–9	9 9	9-9
Infralabials	11–13	13–13	13–14	12–12	14–12	10–12	13-12	13 13
Preoculars	3–3	3–4	3–3	3–3	3–3	3–3	3–3	3–3
Postoculars	3–3	3–3	3–3	3–3	3–3	3–3	3–3	3 3
Loreals	2–2	3–3	2–2	2 2	2 2	3–3	3–3	3–3
Body spots	19	21	20	19	24	21	14	14
Tail spots	11	10	12	13	11	10	7	7
Total length	653	689	575	642	440	574	938	875
Tail.	118	128	101	116	73	90	180	166
Frontal touches preoculars	no*	yes	yes	yes	yes	yes	yes	yes
Temporals	3,3,4 / 3,4,4	3,3,5 / 3,3,5	2,3,5 / 3,4,5	3 4,4 / 3,4,4	3,4,5 / 3,3,5	3 3,4 / 3,3,4	3,1,4,4 / 3,1,4,4	2,3,4 / 2,3,4
Scales touch chinshields	4 4	5-4	5–5	5–5	4-4	5-4	4 4	5 5
Scale rows †	24	25	25	25	25	27	25 27	25-27

* Abnormal.

† The counts are (in the above order) 38, 23, 24, 25, 16; 36, 24, 25, 23, 16; 38, 24, 25, 25, 17; 38, 25, 25, 26, 17; 36, 25, 25, 25, 17; 36, 25, 27, 27, 17; 37, 25, 27, 25, 17; 36, 25, 27, 25, 17.

Trimorphodon paucimaculatus Taylor

Trimorphodon paucimaculatus Taylor, Univ. Kansas Sci. Bull., Vol. XXIV, 1936 (Feb. 15, 1938), pp. 527-529, pl. 46, fig. 1 (type description; type locality, Mazatlán, Sinaloa. Taylor, collector).

This species has been discussed at length in the above publication. No further specimens have been taken.

A character not previously mentioned, which differentiates this form from *bi-scutatus*, is the absence of keels or ridges on the scales in the males. This form is probably confined to the lowland coastal region in Sinaloa, and adjoining states.

Trimorphodon lambda Cope

(Plate XXXV; fig. 4)

Trimorphodon lambda Cope, Proc. Amer. Philos. Soc., 1886, pp. 286, 287 (type description; type locality, Guaymas, Sonora; Emerich, collector); Bull. U. S. Nat. Mus., No. 32, 1887, p. 68; Proc. U. S. Nat. Mus., 14, 1891 (1892), pp. 678-679; Ann. Rept. U. S. Nat. Mus., 1898 (1900), p. 1104; Taylor, Univ. Kansas Sci. Bull., 24, 1936 (1938) pp. 495-497.

Trimorphodon bi-scutatus Günther, Biologia Centrali-Americana, Rept. Batr., May, 1895, pp. 174-175 (*part.*); Boulenger, Cat. Snakes British Mus. (2), III, 1896, p. 54 (*part.*).

Two specimens in my collection were discussed previously (Taylor *op. cit.*). The dental characters of a third specimen (EHT. 341A. skeleton) follows: Four anterior maxillary teeth enlarged, strongly curved, the first more slender and shorter than the others, the third largest of all the teeth; the middle part of the maxillary occupied by five teeth scarcely half the length and thickness of the preceding teeth; this group followed by one (two on right side) large, grooved fang, slightly curved, directed somewhat backward; seven palatine teeth, the anterior three or four considerably larger than others; about 15 equal ptergoid teeth; about 17 or 18 mandibular teeth, the anterior two or three enlarged.

The relationship of this form is with *Trimorphodon lyrophanes* (Cope). There are apparent differences in dentition and it is likely that two is the normal number of loreals. Known only from southern Sinaloa, Mexico. I suspect the species occurs also in Arizona, where it has probably been confused with *T. lyrophanes*.

Trimorphodon vilkinsonii Cope

(Plate XXXVIII, Text. fig. 1)

Trimorphodon vilkinsonii Cope, Proc. Amer. Phil. Soc., 23, 1886, pp. 285-286 (type description: type locality, Chihuahua, Chihuahua; Wilkinson, collector), and Proc. U. S. Nat. Mus., 14, 1891, p. 679, Günther, Biologia Centrali-Americana, Rept. Batr., May, 1895, p. 174; Cope, Amer. Naturalist, Dec., 1896, p. 1014; and Ann. Rept. U. S. Nat. Mus., 1898 (1900), pp. 1105-1106; Cummins, Copeia, No. 138, 1925, p. 7 (in Texas); Werner, Zool. Jahrb., 37, 1929, p. 181; Stejneger and Barbour, Check list Amer. Amph. Rept., 3d Ed., 1933, p. 128

Trimorphodon wilkinsonii Cope, Bull. U. S. Nat. Mus., No. 32, 1887, p. 68

Trimorphodon upsilon Boulenger, Cat. Snakes Brit. Mus. 2d Ed. Vol. III, p. 55, (*part.*)

The type of this species is USNM No. 14268. Scale formula, 30, 21, 23, 17; upper labials, 11-11, the first five touching the anterior chinshields, which are more than double the size of the posterior. First neck band 5-6 scale rows wide, narrowing medially, while the white border widens medially.

The known range of the species is Chihuahua, Mexico, and extreme western Texas.

A second specimen which I have been privileged to examine is one in the Blanchard collection, collected three miles northwest of El Paso, close to the Rio Grande on the road to Las Cruces, June, 1935. It presents the following characters: Rostral very much wider than high, folding back on the snout so that part visible above is less than one third its distance from frontal, its length about equal to the suture between the supranasals; greatest length of the supranasal three fifths to three fourths the length of prefrontals; suture be-

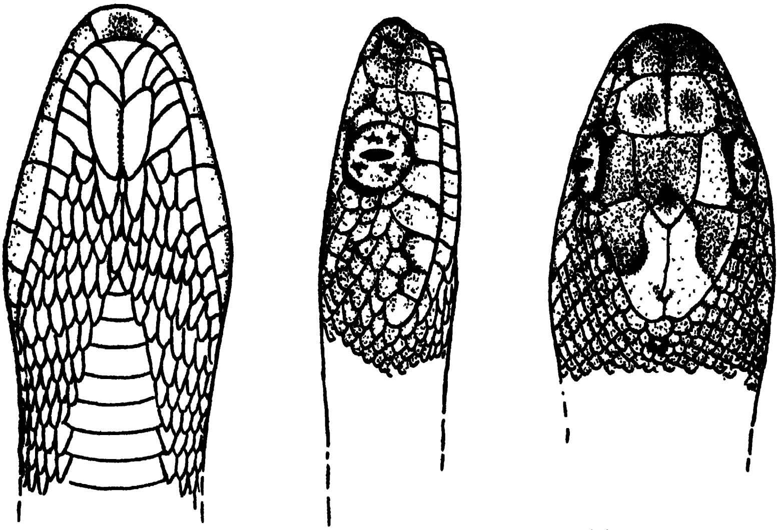

FIG. 1. *Trimorphodon vilkinsonii* Cope. Actual head width, 12 mm.; snout to end of parietal, 16 mm.

tween the internasals less than half the prefrontal suture; frontal width, 3.7 mm.; length, 5.1 mm., slightly shorter than its distance to tip of snout (5.4 mm.); length of parietal, 7 mm.; parietal to tip of snout, 10 mm.; nasal distinctly divided; three loreal scales; three preoculars; three postoculars; upper labials, 9-9, the seventh divided transversely on left side; lower labials, 13-13; temporals, 3 + 4 + 6; 3 + 5 + 5; five labials touch chinshields; second pair of chinshields completely separated; about four pairs of scales between second chinshields and first widened ventral scale; scales with double apical pits; scale formula: 34, 22, 22, 23, 18, 16; ventrals, 228; subcaudals, 79; anal undivided.

Color. Brownish-gray with a series of somewhat irregularly-shaped blackish transverse blotches; first, 9 or 10 scales back of the parietals, somewhat narrowed on the median line, its greatest length equal to seven scales, not reaching third scale row laterally; this blotch followed by 27 blotches on body and tail; each blotch is grayish in the middle, and is bordered by creamy gray; 9 blotches on tail; forty-five pairs of ventrolateral spots touching outer scale row, but for the most part on the ventrals, occasionally confluent with the dorsal blotches, which usually terminate on second scale row (except first blotch which is narrowest of all). The markings on the head are diffuse, but there is evidence of a pattern with darker areas on the prefrontals, frontal and parietals.

I owe thanks to Dr. H. K. Gloyd for the privilege of studying this specimen.

There is a third specimen of this rare species now in the American Museum of Natural History, collected at a point "five miles north of El Paso, Texas, on the east slope of Mt. Franklin."

Trimorphodon lyrophanes (Cope)

Lycodon lyrophanes Cope, Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 343 (type description; type locality, "Cape St. Lucas," Baja California).

Trimorphodon lyrophanes Cope, Proc. Acad. Nat. Sci. Philadelphia, 1861, p. 297; Proc. Amer. Philos. Soc., 1886, p. 286; Bull. U. S. Nat. Mus., No. 1, 1875, p. 38; and *idem*. 32, 1887, p. 68; Proc. Amer. Philos. Soc., Apr. 1886, XXIII, No. 122, p. 286; Cope. Proc. U. S. Nat. Mus., XIV, 1891 (1892), p. 679; Van Denburgh, Proc. Cal. Acad. Sci., (2), 5, 1895, p. 155; Mocquard, Nouv. Arch. Mus. Hist. Nat., Paris, (4), I, 1899, p. 330; Cope, Ann. Rept. U. S. Nat. Mus., 1898 (1900), p. 1102, fig. 314; Stejneger and Barbour, Check list N. Amer. Amph. Rept., 1917, pp. 104-105,; and 2d Ed., 1923, p. 118; and 3d Ed., 1933, p. 127; Van Denburgh and Slevin, Proc. Cal. Acad. Sci., (4), 11, No. 4, 1921, p. 70; Schmidt, Bull. Amer. Mus. Nat. Hist., 46, 1922, p. 697; Van Denburgh, Occ. Papers California Acad. Sci, X, Vol. 11, Nov. 23, 1922, pp 884-887; Klauber, Trans. San Diego Soc. Nat. Hist., Vol 5, No., 11, 1928, pp. 185-187, 190-192; Werner, Zoöl. Jahrb., 37, 1929, p. 181; Linsdale, Univ. California Publ. Zoöl, 38, No. 6, 1932, p. 383.

Klauber (1928) gives the following data on the scutellation of this form: "Scale rows usually 22 or 23 (rarely 20, 21 or 24). Ventrals: 223 to 243, average 232. Anal generally divided (13 divided, 1 entire). Caudals, 68 to 81 pairs, average 73; supralabials, usually 8 or 9, rarely 7 or 10; infralabials, 10-14; preoculars, 2 or 3, normally 3; postoculars, normally 3, rarely 4. Loreals two, with a posterior subloreal usually present. Temporals, 2+3 or 3+4, occasionally 2+4 or 3+3. Body spots, 21 to 33, average 27.5; tail spots, 10 to 14, average 12."

It will be noted that *T. lyrophanes* differs from *lambda* in having a smaller number of spots on the tail (In *lambda* 17 to 18); a slightly lower range of subcaudals (83-87 in *lambda*) and, as pointed out under the discussion of *lambda*, there is considerable difference in the teeth.

The known range is Baja California, Arizona, and very probably also northern Sonora.

Trimorphodon vandenburghi Klauber

(Plate XXXVI, fig 1)

Trimorphodon vandenburghi Klauber, Bull. Zoöl. Soc. San Diego, No. 1, June, 1924, pp. 17-18, fig. 8 (type description; type locality, Wildwood Ranch [elevation 1,520 feet] near Ramona, San Diego county, California, E. B. Woodworth and L. M. Klauber, collectors); Trans. San Diego Soc. Nat. Hist., V, No. 11, 1928, pp. 183-194, plates 22, 23 (Los Angeles, Riverside, and San Diego counties, Southern California); Bull. San Diego Nat. Hist. Soc., No. 4, 1928, p. 5; Copeia, No. 170, 1929, p. 21, (Kern and Imperial counties, California); Bull. San Diego Nat. Hist. Soc., No. 5, 1930, p. 6; and No. 8, 1931, pp. 3, 10, 12, 16, 17, 18, 20, 23, 24, 32, 33, 35, 44, 45, 51, 52, 62, 72; and No. 11, 1934, pp. 20, 21; Stejneger and Barbour, Check list N. Amer. Amph. Rept., 3d Ed., 1933, p. 128 (Kern, Imperial, Inyo and San Diego counties, California).

I collected a single specimen (Kansas University Mus. 8497) of this species from under a flake, pried from a granite boulder a few miles east of San Diego, Cal., September 1, 1928. The specimen agrees with the type description in all pertinent characters. The proximity of this and other records to the Mexican border (Dulzura, San Diego county, from which Klauber [1928] records a specimen, is also near the border) suggests that the species is a habitant of the northern part of Baja California.

Ventrals, 239; anal entire; subcaudals, 65; upper labials, 9-9; lower labials, 12-13, five touching anterior chinshields; preoculars, postoculars and loreals, 3-3; head (mm.), 13.5×11; frontal shorter than its distance to end of snout; 40 blotches on body, 16 on tail; total length, 485; tail, 72.

The undivided anal scute (rarely divided) will separate this form from its congeners in most cases.

Trimorphodon latifascia (Peters)

(Plate XXXVI, fig. 2)

Trimorphodon biscutatus var. *latifascia* Peters, Monatsb. Akad. Wiss. Berlin, 1869, p. 877 (type description; type locality, Puebla, México; Doctor Berkenbusch, collector).

Trimorphodon collaris Cope, Journ. Acad. Sci. Philadelphia, (2), VIII, 1876, p. 13 (type description; type locality, Orizaba, Veracruz; Doctor Sumichrast, collector): and Proc. U. S. Nat. Mus., XIV, 1891, p. 679.

? *Sibon biscutatum* var. *latifasciatum* Garman, Mem. Mus. Comp. Zoöl. VIII, No. 3, 1883, p. 16-17.

Trimorphodon upsilon Boulenger, Cat. Snakes British Mus. (2), III, pp. 55, 56 (*part.*); Cope, Ann. Rept. U. S. Nat. Mus. 1898 (1900), pp. 1104-1105 (*part.*).

The discovery of a specimen of *Trimorphodon*, related to, but distinct from *Trimorphodon upsilon* necessitates the revival of Peters' name *latifascia*. Cope described a species, *Trimorphodon collaris* seven years after *latifascia* was described, but it seems to be a synonym. My specimen was obtained twelve miles south of Puente de Ixtla, Morelos.

Peters' description, though brief, offers the following data: Scales in 21 to 22 rows; ventrals, 206 to 210; 13 to 14 broad, transverse bands on body; 5 to 6 on the tail. Bands gray-brown, edged with black. No distinct V-shaped markings on the head; a bright neck-band, which, upon the parietals, forms a V-shaped indentation and covers the temporal region and three posterior supralabials.

My specimen (EHT No. 5439) and the type of *Trimorphodon collaris* Cope (USNM No. 26499) have the following characteristics, respectively: Ventrals, 218, 211; subcaudals, 78, 79; upper labials, 9-9, 9-9; lower labials, 12-13, 12-12; preoculars, 3-3, 3-3; postoculars, 3-3, 3-3; loreals, 3-2, 3-3; scale formula, 33, 25, 23, 23, 15;

31, 25, 23, 23, 15; scales touching chinshields, 5-6, 4-5; anal divided in both; temporals, 3, 4, 5; (3, 3, 4, 5), and 3, 4, 5; body spots, 15, 16; tail spots, 8, 8. Total length, 256 mm.; tail, 42 mm.

My specimen presents the following additional characters: 8th labial does not reach the lip; rostral very short, about one fifth its distance from the frontal; frontal one fourth longer than its distance from end of snout, and one sixth shorter than the parietals (about as long in type of *collaris*); total length, 256 mm.; tail length, 42 mm.; frontal, 3.5 mm.×2.7 mm.; head, 11.1 mm.×7 mm.; eye, 2.5 mm.; eye to nostril, 2.5 mm. The frontal not in contact with preocular (in contact in type of *collaris*).

The bands on the back are wide, the four anterior on back covering 19, 15, 16, 16 scales, respectively, the intervening red spaces 3½ or 3 scales wide on median line; the black bands are much narrowed below, the first four covering 8, 9, 9, 7 ventrals while the intervening reddish color covers 10, 9, 9, 10 ventrals; posteriorly the dark bands become narrowed, covering four or five ventrals; the reddish areas cover 12 ventrals. However, throughout the body there are intercalated dark spots tending to divide the red areas, crossing ventrals and extending up to fourth lateral scale row; the black bands have a trace of a white line dividing the spots transversely.

The top of the head is black, less dense on the tip of snout; the first red collar is about four scales wide medially, tending to encroach on the parietals; last three labials red, the fourth to sixth with red spots (reddish areas probably brown in adults).

Trimorphodon upsilon Cope

(Plate XXXV, fig. 2)

Trimorphodon upsilon **Cope, Proc. Amer. Philos. Soc., XI, 1869, p. 152 (type description; type locality, "Guadalaxara" West Mexico, I. I. Major, C). and *idem*, XXIII, 1886, p. 286; Bull. U. S. Nat. Mus., No. 32, 1887, p. 68 (Batopilas, Chihuahua; Guanajuato; Zacualtipan, Hidalgo); Cope, Proc. U. S. Nat. Mus., XIV, 1891, p. 678. Gunther, Biologia Centrali-Americana, Rept., May 1895, p. 175 (Ventanas, Durango, Guanajuato; La Cumbre de los Arrastrados, Jalisco [?]; Jalapa, Veracruz); Boulenger, Cat. Snakes Brit. Mus., 2d Ed, III, 1896, p. 54; Cope, Ann. Rept. U. S. Nat. Mus., 1898 (1900), pp. 1104-1105, fig. 315; Mocquard, Bull. Soc. Phil. Paris (9), I, No. 4, 1899, p. 157 ("Sierra del Nayarit"); Gadow, Proc. Zoöl. Soc. London, June 6, 1905, pp. 224, 231, 233 (distribution); Mocquard, Mission Scientifique au Mexique et dans l'Amérique Centrale, Rept., livr. 16, 1908, pp 910-911, pl. 74, figs. 2, 2a, 2b; Gadow, Zoöl. Jahrb., Bd. 29, Heft. 6, 1910, pp. 666, 697, 701, 702 (ranges in elevation from about 1,000 feet to 7,000 feet); Amaral, Mem. Inst. Butantan, IV, 1929, p. 202.**

Eteirodipsas biscutata **Jan, Icon Ofid. XXXIX, 1872, pl. I, fig. 3.**

Sibon upsilon **Garman, Mem. Mus. Comp. Zoöl., VII, No. 3, 1883, p. 134.**

A single specimen (EHT, No. 4569; length, 656; tail, 130 mm.) of this species was taken by Dr. Hobart Smith near Magdalena, Jalisco, June 17, 1935, at an elevation of 1,300 m. I have also

examined several specimens of this form in the United States National Museum. Several specimens lack locality data. These are USNM. Nos. 9912 (2 specimens), 25361, 26138, and 26139. They were collected by Dugès and are probably from Guanajuato. Nos. 21419 and 31358, Type, Guadalajara, Jal; No. 46334, San Juan Capistrano, Zacatecas.

The range of the form is chiefly in western Mexico from Chihuahua south through Durango, Guanajuato, Jalisco and Nayarit. Cope's (1887) specimen from Zacualtipan, Hidalgo, and Günther's (1895) from Jalapa, Veracruz, are the only records for the eastern side of the plateau.

The following table includes data taken from certain of these specimens.

Table of data on *Trimorphodon upsilon* Cope

Number	9912	9912A	12419	25361	26138	4569	31358	46334
Museum	USNM	USNM	USNM	USNM	USNM	EHT	USNM	USNM
Sex	♂	♀	?	♀ (?)	♀	♂	♂	♀
Ventrals	217	228	218	223	211	222	222	232
Subcaudals	69	59	62	66	68	75	73	61
Preoculars	3-3	3 3	3-3	3–3	3 3	3 3	3-3	3-3
Postoculars	3-3	3–3	3-3	3 3	3 3	3-3	3-3	3 3
Loreals	3-3	3 3	2-2	3-2	2 2	2 2	3-3	3-3
Upper labials	8–8	8–8	8-8	8 8	8-8	8 8	8 8	9-9
Lower labials	12 12	13–13	12-12	11–12	12 12	12-11	11-11	11 13
Scales touch chinshields			4-4	4 4		4 4	4 5	5-5
Temporals		3,3,4				3,4,5	3 3,3	2,4,5
Bands, body	30	28	23	31	28	25	24	29
Bands, tail	15	11	11	13	15	13	13	11

Scale formulae, No. 9912, 31, 22, 22, 21, 15; 9912A, 30, 23, 23, 24, 16; 26138, 32, 24, 22, 22, 16; 4569, 30, 22, 22, 17, 15.

Trimorphodon tau Cope

Trimorphodon tau Cope, Proc. Amer. Philos. Soc., 9, 1869, p. 152 (type description; type locality, Isthmus of Tehuantepec, México); and *idem*, Vol. 23, 1886, p. 286; Bull. U. S. Nat. Mus., No. 32, 1887, p. 68; Proc. U. S. Nat. Mus., 14, 1891, p. 678 (key); Günther, Biologia Centrali-Americana, Rept. Batr., May 1895, p. 174; Boulenger, Cat. Snakes Brit. Mus., 2d Ed. 1896, p. 56; Cope, Ann. Rept. U. S. Nat. Mus. 1898 (1900), p. 1101; (?) Mocquard, Bull. Soc. Phil. Paris (9), I, No. 4, 1899, p. 157 (Jalisco, Diguet, collector); Mocquard, Mission Scientifique au Mexique et dans l'Amérique Centrale, Rept., livr. 16, 1908, p. 912; Gadow, Proc. Zoöl. Soc. London, 1905, p. 224; Amaral, Mem. Inst. Butantan, IV, 1929, p. 202.

The type of the species is probably the only known specimen. Mocquard (1899) lists a specimen from Jalisco, but later (Moc-

quard, 1908) states that the type is the only known specimen. Whether the specimen listed in 1899 is lost or has received another designation I cannot say.

I have examined the type (USNM. No. 30338, Tehuantepec, Sumichrast, collector). It is in rather bad condition, being much softened. The striking head pattern is still quite evident. The scale formula is 31, 21, 23, 15. It is known definitely only from the type locality. The following data are given in the type description:

Scales in twenty-three series. Muzzle projecting considerably beyond the mouth. Rostral plate somewhat produced behind; internasals about one fourth size of prefrontals, which are as long as wide. Frontal with straight lateral margins. Parietals not longer than frontal, regularly rounded behind. Nostril in middle of nasal. Three loreals, three postoculars, three preoculars. Temporals, 2 + 3 + 4; six upper labials, the fifth probably composed of two plates fused, as it is twice as long as deep on both sides. The fourth and fifth enter the orbit, the third is cut down by the lower loreal and preocular. Lower labials, eleven. Body strongly compressed. Total length, 236; tail, 35.

Above gray with twenty-three jet-black rhombs, which extend to the ventrals by their lateral angles. Tail with ten rhombs; sides of belly black spotted. Head gray with a black mark above as far as the middle of the parietals, but with two, lateral, ear-shaped projections on the same; a pale T-shaped mark extends transversely between the orbits, and longitudinally to the end of the muzzle.

Hypsiglena Cope

Leptodeira (*part.*) Gunther, Ann. Mag. Nat. Hist. (3), V, 1860, p. 170.

Hypsiglena Cope, Proc. Acad. Nat. Sci. Philadelphia, June, 1860, p. 246 (generic description, type *ochrorynchus*).

Pseudodipsas Peters, Monatsb. Akad. Wiss. Berlin, 1860, p. 521

Comastes Jan, Elenco Sist. Ofid., 1863, p. 102.

Body small, slender, somewhat cylindrical; head distinct from body, the snout projecting beyond mouth; head plates normal; two nasals distinct or united above nostril; two (or three) preoculars, two postoculars; loreal present. Temporals, normally 1-2; scales smooth (save on sides above anus in males), in 19-21 rows; apical pits single; anal plate divided; eye very small, pupil vertically elliptic; tail very short, less than one fourth body length; ventrals not angulate; subcaudals divided; anterior maxillary teeth four to eight, subequal, followed after a space by one or two large, ungrooved, fanglike teeth.

I am fully convinced that the species here considered under this

genus, *H. torquata torquata*, *H. t. dunklei subsp. nov.*, *H. affinis*, and *H. ochrorhynchus*, form a generic group related to *Leptodeira*, but differing in having the snout projecting more, a proportionally smaller eye, a much shortened tail, usually less than 10 maxillary teeth, single apical pits, posterior fangs lacking grooves; a smaller number of subcaudal scales. I have not regarded *Leptodeira guilleni* Boulenger (*Hypsiglena latifasciata* Günther) or *Leptodeira discolor* Günther as belonging in the genus *Hypsiglena*.

Günther (Oct., 1894), *loc. cit.*, confused his specimens of *Hypsiglena*, throwing together as one species all the species here recognized (*i. e., torquata, ochrochynchus,* and *affinis*). Boulenger (1894) on the other hand, using the same specimens available to Günther, recognized the three species.

With accumulation of more material from western Mexico it will be possible, no doubt, to demonstrate that certain forms included under *torquata torquata* are worthy of subspecific designation.

KEY TO THE FORMS OF HYPSIGLENA

A. Scales in 19 rows around middle of body; a single preocular; upper labials 7, lower labials 10; ventral-subcaudal count 207-213; head narrow, with about 23 scales about posterior part of head; a light nuchal band.......... *H. affinis* Boulenger,

AA. Scales in 21 rows around middle of body; two preoculars (1 preocular, one subocular); upper labials 7 or 8;

B. No light neck band; first nuchal spot single (rarely divided into two or three parts) connecting with dark lines behind eyes ...... *H. ochrorhynchus* Cope,

BB. A light nuchal band, not or rarely interrupted medially or laterally, sometimes involving part of parietal region.

C. Rostral large, pushing far in between prefrontals, the part visible about equal to three fourths the distance between rostral and frontal; head broad, 30 scales about posterior part of head; 8 upper labials; 11 lower labials; knobs or keels on lateral scales above anus in males; 162 ventrals; 57 subcaudals (male)........*H. torquata dunklei* subsp. nov,

CC. Rostral not pushing between the prefrontals or but slightly; part visible above equal to one half or less of the distance between the rostral and frontal; 25 or less scales about back part of head; upper labials, 7 or 8; lower labials, 9 or 10; apparently no scales with keels or knobs on sides above anus in males; ventrals, 164-174; subcaudals, 36-56 *H. torquata torquata* Günther.

Hypsiglena ochrorhynchus Cope

Hypsiglena orchrorhynchus Cope, Proc. Acad. Nat Sci. Philadelphia, 12, Nov. 15, 1860, p. 246 (type description; type locality, "Cape St. Lucas," Baja California, John Xantus, collector); and Bull. U. S. Nat. Mus., No. 1, 1875, p. 38; Lockington, Amer. Nat., XIV, 1880, p. 295; Yarrow, Bull. U. S. Nat. Mus., No. 24, 1883, pp. 15, 97 (Cape San Lucas, La Paz, Baja California; Durango, Mexico); Garman, Mem. Comp. Zoöl., Harvard College, VIII, No. 3, 1883, pp. 80, 161; Cragin, Bull. Washburn College Lab. Nat. Hist., I, 1884, p. 8 (Guaymas, Mex.); Cope, Proc. Amer. Philos. Soc. Philadelphia, XXIII, p. 285 (Chihuahua); and Bull. U. S. Nat. Mus., No. 32, 1887, p. 78; Belding, West Amer. Scient., III, No. 24, 1887, p. 98; Cope, Proc. U. S. Nat. Mus., XIV, 1891 (1892), p. 617; Stejneger, N. Amer. Fauna, No. 7, May, 1893, pp. 204, 205 (Cape St. Lucas); Boulenger, Cat. Snakes British Mus., Vol. II, 1894, p. 209; Van Denburgh, Proc. Cal. Acad. Sci. (2), Vol. 5, 1895, p. 145; Occ. Papers Cal. Acad. Sci., V, 1897, p. 178; Mocquard, Nouv. Arch. Mus. Hist. Nat., Paris, (4), I, 1899, p. 325 (Mulege, Baja California); Cope, Ann. Rept. U. S. Nat. Mus.,

1898 (1900), p. 953, fig. 245; Brown, Proc. Acad. Nat. Sci., Philadelphia, 1901, p. 87; Van Denburgh, Proc. Cal. Acad. Sci. (3), Zoöl., Vol. 4, No. 5, 1906, p. 65; Ditmars' Reptile Book, 1907, p. 329, pl. CI, fig. 1; Grinnell, Univ. Cal. Publ. Zoöl., Vol. 5, No. 1, 1908, p. 165; Van Denburgh and Slevin, Proc. California Acad. Sci. (4), Vol. 3, 1913, p. 414; Atsatt, Univ. California Publ. Zoöl., 12, No. 3, 1913, p. 42; Ruthling, Copeia, No. 15, 1915; Van Denburgh and Slevin, Proc. California Acad. Sci., (4), 5, 1915, p. 106; Grinnell and Camp, Univ. California Publ. Zool., 17, No. 10, p. 188; Bentley, Copeia, No. 61, 1918, p. 83; Cowles, Journ. Ent. Zoöl. Pomona College, XII, 3, 1920, 66; Stevens, Trans. San Diego Soc Nat. Hist. III, 4, 1921, p. 64; Nelson, Mem. Nat. Acad. Sci., XVI, 1921, pp. 114, 115; Klauber, Bull. Zoöl. Soc. San Diego, No. 8, 1931, p. 71, and No. 9, 1932, pp. 25, 80; and Copeia, Oct. 7, 1932, No. 3, p. 126; Linsdale, Univ. California Publ. Zool., 38, No. 6, 1932, p 380 (San Ignacio, Comondú and Eureka in Baja California). Stejneger and Barbour, Check list N. Amer. Amph. Rept., 3d Ed., 1933, p. 113; Allen, Occ. Papers Mus. Zool. Univ. Mich., No. 259, p 12 (Hermosillo, Son.); Klauber, Bull. Zool. Soc. San Diego, No. 11, 1934, p. 19; Taylor, Univ. Kansas Sci. Bull., 24, 1936 (Feb. 15, 1938), pp. 494-495.

Hypsiglena chlorophaea, Cope, Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 247 (type description; type locality, Fort Buchanan, Arizona, Irwin, collector); Stejneger, N. Amer. Fauna, No 7, 1893, p 205; Mocquard, Nouv. Arch. Mus. Hist. Nat., Paris, (4), 1, 1899, p. 325, and Mission Scientifique au Mexique et dans l'Amérique Centrale, livr. 16, 1908, p. 869, pl. 69, fig. 1. 1a-d; Garman, Bull. Essex Inst., 16, Jan. 9, 1884, p. 30.

Hypsiglena ochrorhynchus chlorophaea Cope, Proc Acad. Nat. Sci. Philadelphia, 1866, p. 304; and Bull U. S Nat. Mus., No 1, 1875, p. 38 (Arizona); Coues, Wheeler's Rept. Surv. W 100th Merid., V, 1875, p 622; Yarrow, Bull. U. S. Nat. Mus. No 24, 1883, pp. 15, 97, 190; Garman, Mem. Mus. Comp. Zool, Harvard College, VIII, No. 3, 1883, pp. 80, 161; and Bull Essex Inst., 16, 1884, p. 30.

Hypsiglena torquata Biologia Centrali-Americana, Rept. Batr, Oct., 1894, p. 137 (*part.*); Mocquard, Mission Scientifique au Mexique et dans l'Amérique Centrale, Rept., livr 16, 1908, pp. 866-868, pl. 69, figs. 3, 3a, 3c, 3d (*part*) (He states, Bocourt believed *H. ochrorhynchus* distinct from *H. torquata*).

Hypsiglena ochrorhynchus ochrorhynchus Stejneger and Barbour, Check list N. Amer. Amph. Rept., 1917, p. 93; Van Denburgh and Slevin, Proc. California Acad. Sci., (4), XI, 1921, pp 28, 52, 68; Schmidt, Bull. Amer Mus Nat Hist, XLVI, Dec 7, 1922, p. 692; Klauber, Bull. Zoöl Soc San Diego, No. 1, June 1, 1925, p. 16; Van Denburgh, Occ. Papers California Acad. Sci., X, 2, pp 780, 783, pl 85; Stejneger and Barbour, Check list N. Amer. Amph Rept., 2d Ed., 1923, p. 104.

Leptodeira torquata venusta Dunn, Proc. Nat. Acad Sci. 22, 1936, pp 691, 695

Leptodeira torquata ochrorhynchus Dunn, Proc. Nat. Acad. Sci 22, 1936, pp. 691, 695.

Hypsiglena texana Stejneger N. Amer Fauna., 7, May, 1893, p 205 (type description: type locality, "between Laredo and Camargo, Texas), Strecker, Baylor Bull., XVII, No. 4, 1915, p 40

Hypsiglena ochrorhynchus texana Stejneger and Barbour, Check list N Amer. Amph. Rept , 1917, p. 93; 2d Ed. 1923, p. 104

I have hesitated to venture an opinion on the validity of the supposed species, *Hypsiglena venusta* Mocquard, *Hypsiglena chlorophaea* Cope or *Hypsiglena texana* Stejneger, because of insufficient specimens. It is likely that when sufficient material is available, certain of these will be recognized as subspecific forms. (Dunn, 1936, has recently recognized *venusta*.) Differences in the character of the skull is marked in specimens from San Diego county, California, Northern Mexico and Arizona. The snout is short and blunt in the former, elongate and projecting over the mouth in the latter.

The species is represented in my collection by six Mexican specimens, from the following localities: EHT, No. 4595, 1½ miles northwest of Saltillo, Coah., August 24, 1932, H. M. Smith; 4596, five miles southwest of Hermosillo, Sonora, June 22, 1934; 4597, near La

Posa, 10 miles northwest of Guaymas, Sonora, June 20, 1934; 4598, five miles northwest of Guaymas, Sonora, 1934; 4599, 32 miles west of San Pedro, Coah., August 25, H. M. Smith; 5202, Huasteca Cañon, 11 miles west of Monterey, Nuevo León, June 16, 1936. (Unless otherwise mentioned, the specimens were collected by me.) The scale formula for the three Sonora specimens is 21, 21, 17, 15; that for the three specimens from Nuevo León and Coahuila is 21, 21, 19, 17.

Table of data and measurements (in mm.) of *Hypsiglena ochrorhynchus* Cope.

Number	4597*	4598	4596	4595	4599	5202
Sex	♀	♂	♂	♀	♂	♀
Ventrals	177	181	178	175	174	172
Subcaudals	54	63	60	41	56	41
Supralabials	8-8	8-7	8-8	8 8	8-8	8-8
Infralabials	10-10	10-10	10-10	11 11	10 10	10-10
Preoculars	2-2	2-2	2 2	2 2	2 2	2-2
Postoculars	2 2	2 2	2 2	2 2	2 1	2 2
Temporals	1 2-3	1 2-3	1 2-3	1 2 3	1 2 3	1 2 3
Anal	2	2	2	2	2	2
Total length	408	397	390	365	362	391
Tail	69	73	74	53	66	55
Frontal length	4	3.9	4 2	3 6	4	3.8
Frontal width	2.5	2 3	2.7	2 8	2 3	2 8
Head length	17	16	15.8	15	13.5	13 7
Head width	10	9 6	9	9.2	9	9 3
Eye	2.3	2.3	2.3	2 15	2 2	2.2
Eye to nostril	2 8	2.95	2.8	3	2.8	2 6
Spots	59?	70	70	53	49	56

* The numbers 4596, 4597, 4598 bore the field numbers of 120, 266, 281, respectively, and are so referred to in Taylor (1936). The total length as given is in error. These are snout-to-vent measurements. No. 281 should read, 326 mm.

Hypsiglena affinis Boulenger

(Plate XXXVII, fig. 3)

Hypsiglena torquata Günther, Biologia Centrali-Americana, Rept. Batr., Oct. 1894, p. 137 (*part.*).

Hypsiglena affinis Boulenger, Cat. Snakes British Mus., II, 1894, pp. 210, 211, pl. 8 (type description; type locality Zacatecas and Jalisco); Mocquard, Bull. Soc. Phil. Paris, (9), I, No. 4, 1899, p. 157 (Guadalajara); and Mission Scientifique au Mexique et dans l'Amérique Centrale, Rept. livr. 16, 1908, pp. 868-869, pl. 69, figs. 2, 2a, 2b, 2c (México); Werner, Zoöl. Jahrb, 57, 1929, pp. 124, 125 (Key).

Leptodeira torquatus torquatus Dunn., Proc. Nat. Acad. Sci., 22, 1936 (*part.*).

This species is represented in the collection by a single male specimen, No. 4601, collected by H. M. Smith, near Magdalena, Jalisco, June 1, 1935. It agrees generally with the type description.

Scale formula, 23, 19, 19, 17, 15; ventrals, 162; subcaudals, 45; anal divided; upper labials, 7-7; lower labials, 10-10; preoculars, 1-1 (no subocular); postoculars, 2-2; temporals, $1 + 2 + 3$; 5 labials touch anterior chinshields, which are very distinctly larger than the posterior; scale pits single; order of size of labials, 1, 2, 3, 4, 7, 6, 5. Total length (mm.), 297; tail, 46; frontal, 3×2.7; head length, 10; width, 7.6; eye, 1.7; eye to nostril, 2; maxillary teeth, 4, with four interspaces (which probably bear teeth normally) followed, after a short diastema, by a pair of enlarged fanglike, ungrooved teeth.

The general ground color is gray-brown with a median series of spots and three lateral series on each side, the median spots largest, but some tending to break in two on the median line. The smaller lateral spots are arranged to alternate with the median spots and with each other. The head is brownish, and a narrow longitudinal nuchal line is present. The nuchal collar is cream color. The first dark nuchal blotch covers six to eight scale rows; the cream collar, which precedes it, covers six scale rows. The dark band running back from the eye does not cross the cream collar to join the dark nuchal blotch laterally. The band is bordered by a narrow white line above and below. Very slight pigmentation is evident on the edges of the chin. Below, the abdomen and subcaudal regions are white. On the sides above the anus, the scales bear rounded, knoblike tubercles or keels (probably present only in males).

I am convinced that this form is distinct from either *H. torquata* or *H. ochrorynchus*, on the basis of the presence of only 19 scale rows, the absence of the lower preocular (subocular) and the characteristic color pattern.

The present known distribution includes Zacatecas, and Jalisco in México.

Hypsiglena torquata torquata Günther

(Plate XXXVII, fig 3)

Leptodeira torquata Günther, Ann. Mag. Nat. Hist. (3), V, Feb. 1860, p. 170, pl. 10, fig. A (type description; type locality, Laguna I., Nicaragua); Trooschel, in Muller, Reisen in den Vereinigten Staaten, Canada und Mexico, III, 1865, p. 612.

Pseudodipsas fallax Peters, Monatsb. Akad. Wiss. Berlin, 1860, p. 520.

Liophis janii Dugès, Mém. Ac. Montpelier, VI, 1866, proc.-Verb. p. 32 (*fide* Boulenger).

Comastes quincunciatus Jan, Elenco Sist. Ofid., 1863, p. 102, and Icon. Gen. Ofid., 38, 1871, pl. 1, fig. 1. ("Mazatlan," "Costa Rica," "Caracas," "Mexico"); Troöschel, in Müller, Reisen in den Vereinigten Staaten, Canada und Mexico, III, 1865, p. 612.

Hypsiglena torquata Cope, Bull. U. S. N. M., No. 32, 1887, p. 78; Günther, Biologia Centrali-Americana, Rept. Batr., Oct., 1895, p. 137 (*part.*); Boulenger, Cat. Snakes British Mus., II, 1894, p. 210, 359 (Ventanas, Durango; Presidio, near Mazatlán, Sin.; Nicaragua); Gadow, Proc. Zoöl. Soc. London, June 6, 1905, pp. 224, 241; Mocquard, Mission Scientifique au Mexique et dans l'Amérique Centrale, Reptiles, livr. 16, 1908, pp. 867, 868 (*part.*) figs 3 (?); Werner, Zoöl. Jahrb., 57, 1929, pp. 124, 125.

Leptodeira torquata torquata Dunn, Proc. Nat. Acad. Sci. 22, 1936, pp. 691, 694, 695 (*part.*)

This species is represented by two specimens collected twelve miles south of Puente de Ixtla, Morelos. Both were collected from under rocks. The following data are taken from EHT. Nos. 5200, 5201, respectively (measurements in mm.); sex, ♀, ♀; scale formula 25, 21, 21, 19, 17 in both; ventrals, 166, 164; subcaudals, 39, 36; upper labials, 7-8, 7-7; lower labials, 9-10, 9-9, the first pair separated; preoculars (pre- and subocular), 2-2, 2-2; postoculars, 2-2, 2-2; temporals, 1 + 2 + 3, 1 + 2 + 3 (2 + 2 + 3 on right side); scales touching first chinshields, 4-5, 4-4; total length, 460, 412; tail length, 59, 54; scale pits single; anterior chinshields largest or equal in size to second pair; white collar, 4 scale rows wide; frontal longer than distance to end of snout in both; frontal length, 4.2, 4; frontal width, 3.1, 2.9; head length, 15.3, 14.3; head width, 11, 10; eye length, 2.2, 2; eye to nostril, 3, 2.8; spots on dorsal line approximately, 56, 52. The anterior maxillary teeth are 4 on each side (with probably four missing teeth, making a total of eight on each side), followed by two large fangs, which show no trace of a groove. There is a nuchal dark line in one, only small spots in the other, neither connecting with the large dark nuchal blotch. This blotch is four scale rows long medially, seven or six and one half long laterally. The dorsal pattern of both specimens consists of a median series of spots which are divided in two at one or two regions on the back; when unbroken the spots are quadrangular and separated by transverse cream lines. The spots are brownish lavender on a dull, gray-lavender; two rows of smaller dots laterally; top of head dark with minute whitish flecks; a diagonal cream-white line from below the eye and a white line along the lower labials; a broad brown band from eye to jaw angle, bordered above with cream; chin heavily pigmented; outer edges of the ventrals with some pigment.

USNM No. 31385 ♂, Colima, Mexico. Xantus coll. This specimen shows certain anomalies. The prefrontals fused; posterior chinshield longer than anterior; 4 scales touch anterior chinshields; upper labials, 8-7; lower labial, 8-8; 2 preoculars; 2 postoculars; rostral pushing between the internasals slightly. One very large anterior temporal on left side, with a tiny scale below (destroyed on left side); frontal, length, width 3.5 mm. × 2.7 mm.; parietal, 4.5 mm. long; parietal to end of snout, 5 mm.; nasal divided; eye diameter, 1.7 mm.; eye to nostril, 2 mm.; scales preceding divided

preanal, partially fused; scale formula, 22-21-21-17-15; ventrals, 166; subcaudals, 42. Typical markings; slight amount of pigment on anterior chinshields; slight pigment on edges of ventrals; about 52 median dorsal spots. Head flecked with deep brown.

USNM No. 51479 ♀, San Blas (?Nayarit), Mexico. Prefrontals normal; rostral short above, not pushing between internasal; posterior chinshields longer than first; two preoculars; two postoculars; temporals, 1 + 2 + 3, frontal length, width 3 × 2 mm.; frontal to tip of snout, 2.7 mm.; parietal, 4.2 mm.; upper labials, 8-8; lower labials, 10-10; scale formula, 26-21-21-19-17; ventrals, 171; subcaudals, 39. Anal divided. Five scales touch first chinshields, which are shorter than posterior pair. First neck band notched behind, 7 or 8 scale rows wide; 3-4 scale rows behind parietal, white; head flecked with deep brown; 54 dorsal spots. Total length, 295 mm.; tail, 40 mm.; head length, 12 mm.; width, 6.5 mm.

USNM 46513. Tupátaro, Michoacán, has a band on neck with a narrow median and two lateral projections pushing forward, the lateral ones connecting with the line behind eye; head light, finely flecked to between eyes. This marking on neck is strongly suggestive of the nuchal mark in *H. ochrorhynchus*.

The parietals are short (5.3 mm.); parietal to end of snout, 6.5 mm.; frontal length (4 mm.) equal to its distance from tip of snout; anterior chinshields equal to second pair; 4-5 scales touch first chinshields; labials 4 and 5 enter eye; diameter of eye, 2.4 mm.; distance between eye and nostril, 3 mm.; scale formula, 26-22-21-21-18-16. Upper labials, 8-8; two preoculars; nasal divided, the posterior part very large; ventrals, 173; subcaudals, 38. Total length, 420 mm.; tail, 54 mm.; length of head, 18 mm.; width of head, 10.4 mm.

I am indebted to Dr. Leonhard Stejneger and Dr. Doris Cochran for the privilege of studying these forms in the National Museum.

Boulenger's specimens from Ventanas, Durango and Presidio, Mazatlán, Sinaloa, appear to agree in general with my specimens. These three specimens are males with the following combined (ventral-subcaudal) scale counts: 222, 219, 221; the Guerrero (female) specimens, 200, 205. This maximum-minimum variation 14-22 is comparable to the variation of 12 in the types (presumably male and female). The probability is that 7-7 is the normal formula for upper labials in western Mexican specimens.

Hypsiglena torquata dunklei subsp. nov.

(Plate XXXVII, fig. 1)

Holotype. MCZ. No. 42594; collected August 10, 1934, Hacienda, La Clementina, near Forlon, Tamaulipas, by David Dunkle.

Diagnosis. The most northern variant of *Hypsiglena torquata,* varying in the following characters from the typical form: Rostral bent far back over the snout, which is somewhat compressed (wedge-like) rather than rounded; the length of the part visible above more than three fourths its distance from the frontal; prefrontals subtriangular, rather than square, due to the fact that the rostral enters between them, reducing the length of the suture between them; posterior chinshields largest; lower labials, 11-11; loreal irregularly shaped, not square; ventrals, 162, subcaudals, 57; males with tubercular knobs on scales on side above anus; vertical diameter of eye minutely less than one half interorbital distance.

Description of the type. Head rather depressed, the snout extending beyond mouth 1.3 millimeters; width of rostral (2.6 mm.) much less than total length (3.6 mm.), the upper part reflected back over the snout, its posterior point wedged in between the internasals; length of rostral seen above equals three fourths or more of its distance from frontal; suture between the internasals about one half of the length of the scale, length of internasal about two thirds the width (1.5×1 mm.); prefrontals (2.1×1.6 mm.) wider than long; frontal longer than wide (3.3×2.4 mm.), longer than its distance to the tip of the snout, and about equal to length of the parietal, which is equal to the distance from parietal to the internasals; nostril between two nasals, chiefly in the anterior; loreal irregular, much longer than high; two preoculars, upper very large, widely separated from the frontal, the lower wedged in between the third and fourth labial; two postoculars, upper largest; temporals, 1+2+3; (1+3+4); fourth and fifth upper labials enter orbit; mental wider than long; lower labials, 11-11; five touch the anterior chinshields, which are somewhat shorter than the posterior; posterior chinshields almost wholly separated by two scales; six scales between first wide ventral and last lower labial; scale formula, 30, 21, 21, 19, 17; ventrals, 162; anal divided; subcaudals, 57. Scales generally smooth, save that those on sides in anal region have tubercular knobs or keels (probably present only in males); a single apical pit present.

Color (in alcohol). Ground color light buff, with a series of dorsal spots of brown, the spots, separated by narrow light lines about a scale wide, are about the length of three scales; occasionally

one half of the spot will tend to alternate with the other half; a large dark-brown or purplish-brown spot on the neck, about the length of seven scales, reaching laterally to outer scale row; this preceded by a white or cream collar involving the posterior fourth of the parietals, not interrupted on side of neck or medially; snout and head flecked with brown, less dense on the parietals; a wide brownish band from eye to angle of mouth; brownish flecks on anterior upper and lower labials; two rows of lateral spots alternating with the dorsal row; 43 spots on body; 23 on tail; below immaculate.

Measurements (in mm.). Snout to vent, 314; tail, 59; tail, divided by total length, .154; head length, 12.2; width, 8; length of eye, 2; eye to nostril, 2.1.

Remarks. There are eight smaller maxillary teeth preceding two large fanglike teeth; the fangs bear no trace of grooves. The ventral count is lower, the subcaudal count higher than any specimens I have seen of *torquata torquata*.

I am indebted to Mr. A. Loveridge for the privilege of studying this specimen. I dedicate it to Mr. David Dunkle, the collector.

PLATE XXXV

FIG. 1. *Trimorphodon bi-scutatus* (Duméril and Bibron). EHT-HMS, No. 5339.' Hda. El Sabino, Uruapan, Michoacán. Raymond Bresson, collector. Total length, 875 mm.

FIG. 2. *Trimorphodon upsilon* Cope. EHT-HMS, No. 4569. Near Magdalena, Jalisco, Elev. 1300 m. H. M. Smith, collector. Total length, 656 mm.

FIG. 3. *Trimorphodon paucimaculatus* Taylor. Type. EHT-HMS, No. 4570. (Field number 709.) Near Mazatlán, Sinaloa. E. H. Taylor, collector. Total length, 880 mm.

FIG. 4. *Trimorphodon lambda* Cope. Topotype. EHT-HMS, No. 4572. Near Guaymas, Sonora. E. H. Taylor, collector. Total length, 788 mm.

PLATE XXXV

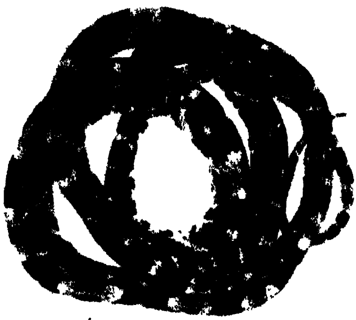

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PLATE XXXVI

FIG. 1. *Trimorphodon vandenburghi* Klauber, K. U. Museum. No. 8497. Near San Diego, Cal. E. H. Taylor, collector. Total length, 485 mm.

FIG. 2. *Trimorphodon latifascia* (Peters). EHT-HMS. No. 5439. Twelve miles south, Puente de Ixtla, Morelos. E. H. Taylor, collector. Total length, 256 mm.

PLATE XXVI

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2.

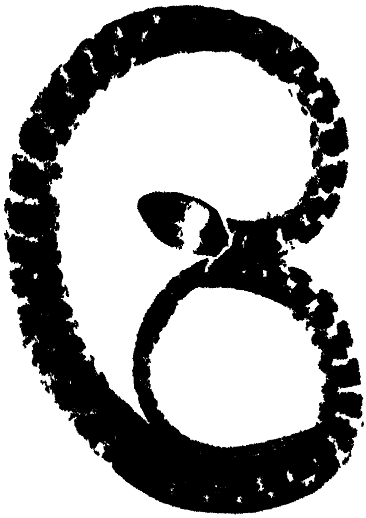
PLATE XXXVII

FIG. 1. *Hypsiglena torquata dunklei* subsp. nov. MCZ, No. 42594. Type. Forlon, Tamaulipas. David Dunkle, collector. Total length, 373 mm.

FIG. 2. *Hypsiglena affinis* Boulenger. EHT-HMS, No. 4601. Near Magdalena, Jalisco. H. M. Smith, collector. Total length, 279 mm.

FIG. 3. *Hypsiglena torquata torquata*. EHT-HMS, No. 5200. Twelve miles south of Puente de Ixtla, Morelos. E. H. Taylor, collector. Total length, 460 mm.

PLATE XXXVII



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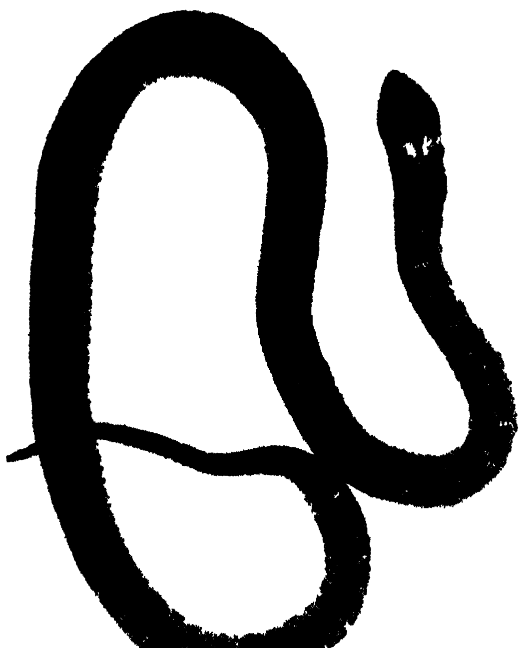


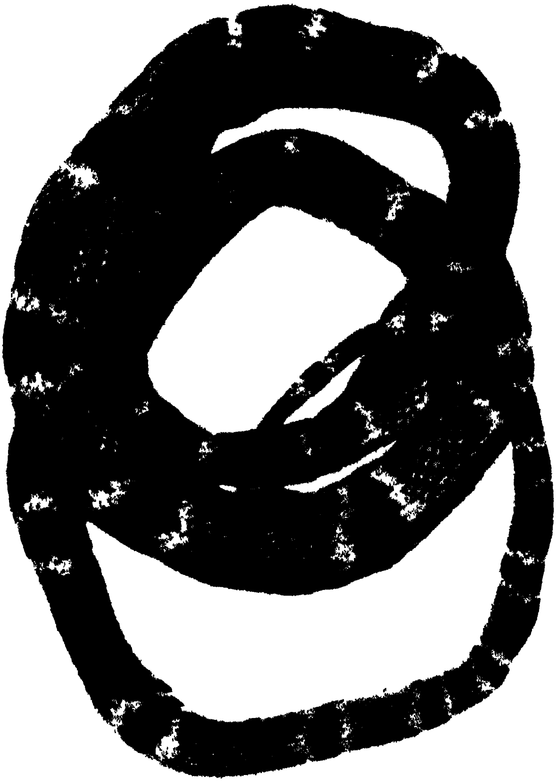
3.

PLATE XXXVIII

Trimorphodon vilkinsonii Cope.

Blanchard collection; collected three miles northwest of El Paso, Texas, June, 1936. (About natural size.)

PLATE XXXVIII



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New Species of Mexican Tailless Amphibia

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ABSTRACT: This paper describes five new species of Mexican anurans: *Hyla rickardsi*, Potrero Viejo, Veracruz (related to *H. loquax*); *Hyla arborescandens*, near *Acultzingo*, Veracruz (related to *Hyla miotympanum*); *Rana sierramadrensis* Agua del Obispo, between Rincón and Cajones, Guerrero (related to *R. palmipes* and *R. zeteki*); *Eleutherodactylus cactorum*, 20 miles northwest of Tehuacán, Puebla (related to *E. augusti*); *Eleutherodactylus natator*, Tlilapam, Veracruz (related to *E. guentheri* and *E. rugulosa*).

FIVE species of tailless amphibians are described in this paper from the collections made in Mexico by Doctor Hobart Muir Smith and myself. They may be characterized as follows:

Hyla rickardsi sp. nov.

(Plate XLI, figs. 1-8)

Type. EHT-HMS, No. 5947, ♂; collected near Potrero Viejo, Veracruz, August 29, 1936, by Mr. and Mrs. Dyfrig McH. Forbes and E. H. Taylor.

Paratypes. EHT-HMS, Nos. 5897-5970; same locality, date, and collectors as type; Nos. 1431-1490, four miles east of Encero, Veracruz, July 17, 1932; E. H. Taylor and H. M. Smith, collectors.

Diagnosis. A medium-sized species most closely related to *Hyla loquax*, but differing in having a canthus rostralis, in having the posterior part of femur pigmented (reddish, lacking dark pigment in *H. loquax*), in having a white line along outer edge of foot and across anal region; the eye and tympanum are proportionally larger.

Vomerine teeth small, directly between choanae; diameter of tympanum about one half length of eye; head wide, the interorbital width much greater than width of an eyelid; a medial vocal sac;

fingers more than half webbed; toes with membranes reaching the base of the disks on the outer side; disk and distal phalanx of the fourth toe free, save for a marginal skin flap; when arm is placed at right angles to body an axillary, winglike web becomes evident, extending along side, reaching two thirds of the distance to elbow; disks on digits moderately large; heel reaches to a point between eye and nostril. Color variable, gray to vinaceous.

Description of the holotype. Head rather broad; eyes prominent, longer than snout (eye 4.2 mm., snout 4 mm.); nostril much nearer tip of snout than eye, the distance between nostrils equal to distance from eye to nostril; canthus rostralis rather angular, continued somewhat in advance of nostrils, the lines when projected intersecting at the tip of the snout; lores sloping but slightly, the region not concave; diameter of tympanum (2 mm.) one half diameter of eye; tympanum distinct, but covered with pigmented skin, separated from eye by a distance equal to two thirds diameter of tympanum; upper eyelid (3.2 mm.) much less than interorbital distance (4.5 mm.).

Vomerine teeth on two raised areas, which are much closer together than to choanae, and wholly between the choanae, which are distinctly larger than a single group of teeth; tongue cordiform, distinctly broader than long, emarginate behind, and free for about one seventh of its length; openings into the vocal sac very elongate (4.5 mm.).

Digital pads on fingers large, those on three outer fingers equal to or larger than tympanum; fingers one half to two thirds webbed; nowhere do the webs reach the disks save by a narrow margin of skin; distal subarticular tubercles large, all single; proximal tubercles on two outer fingers more or less obsolete; palm and webs strongly areolate; a large bean-shaped pad at base of first finger; a pair of small palmar tubercles; no fold or tubercles on under side of humerus; legs long, moderately slender, the tibiotarsal articulation reaches to nostril; toes with disks smaller than those on outer fingers, webbed for three fourths of their length, the web reaching the disk on outer side of first to third toes; a prominent inner and a low, rather indistinct, outer metatarsal tubercle; undersurface of toes, sole of foot and web strongly areolate; a distinct tarsal fold; a strongly defined supratympanic fold extending back to above arm or farther along side. When femur is extended a well-defined axillary web is seen extending about half the length of body, and reaching much more than halfway to the distal end of the humerus. A large vocal sac.

Skin above smooth (under a lens, minutely corrugated); skin on chin is greatly folded, but smooth; chest and abdomen, ventral surface of thigh, and region below anus strongly granular or areolate.

Color. Above vinaceous with numerous spots of a lighter shade and a few scattered black flecks; below yellowish or cream; concealed surfaces of limbs, and axillary web yellowish; pigment on sides of head slightly darker than on back; a white line borders the outer edge of foot and fifth toe; a transverse white line above anus; an indistinct light line borders the canthus and the supratympanic fold. Femur with scattered pigment on dorsal and posterior surfaces; the pigment extends about halfway on the anterior surface of femur; a few scattered, indistinct, whitish or cream spots along the sides; limbs more or less barred with brown; dark-brown stripe on underside of heel, encroaching on sole and underside of fifth toe; remainder of undersurface of foot, and hand without pigment; outer part of the chin with pigment; vocal sac lemon yellow.

Measurements (in mm.). Snout to vent, 37; snout, 4; head length, 11.2; head width, 13; eye length, 4.2; eyelid width, 3.2; interorbital width, 4.5; tympanum, 2; foreleg, 23.6; longest finger, 11; hind leg, 66.5; tibia, 21; foot, 27.5.

Variation. Color variation is great, many of the specimens being a light gray (yellowish gray at night) with the banding on the limbs obscure; others are lavender grayish, lavender, clay or light variegated brown. The color is not associated with sex. In all cases there are small black flecks scattered on the back; the white line on the foot is always present, and lighter lines usually follow the canthi and intersect on the snout.

Remarks. This species has been encountered only twice. Fortunately each time they were found breeding and large series were obtained. The specimens were taken from plants growing out of the water. Many were found clasping, but no eggs were seen. The calls of this species were mingled in a chorus of the voices of *Bufo marinus, Bufo valliceps, Hyla staufferi, Rana pipiens, Rana palmipes* and *Hylella picta.*

Specimens of this form have been compared with the type of *Hyla godmani* Günther by Mr. H. W. Parker,* who points out several differences. This form, which Kellogg has placed in the synonymy of *H. miotympanum,* lacks an axillary web, and the males have a horny excrescence on the thumb which is likewise true of *H. miotympanum.* From Peters' *H. microtis,* which Kellogg places in the synonymy of *H. miotympanum,* it differs in having the

* I wish to acknowledge my debt to Mr. H. W. Parker for this courtesy.

posterior and anterior surface of the femur without pigment and the line on side absent. Other differences likewise obtain.

The only other Mexican frog with which it might be confused is *Hyla loquax*, which likewise has an axillary web, but which differs in numerous characters, the most salient of which are mentioned in the diagnosis. *H. loquax* is known in Mexico only from Tres Brazos and Encarnación, Campeche, where Dr. Hobart Smith discovered it, September 17-19, 1936.

This species is dedicated to Mr. John A. Rickards, Tacubaya, Distrito Federal, who has manifested interest in my studies in Mexican herpetology, and who has presented me with numerous valuable specimens.

Hyla arborescandens sp. nov.

(Fig. 1)

Type. EHT-HMS, No. 3135, ♂; collected on mountainside about 3 km. southwest of Acultzingo, Veracruz, July 22, 1932, by E. H. Taylor and H. M. Smith.

Diagnosis. A medium-sized, olive-colored hyla with strongly-defined canthi which continue onto tip of snout and intersect;

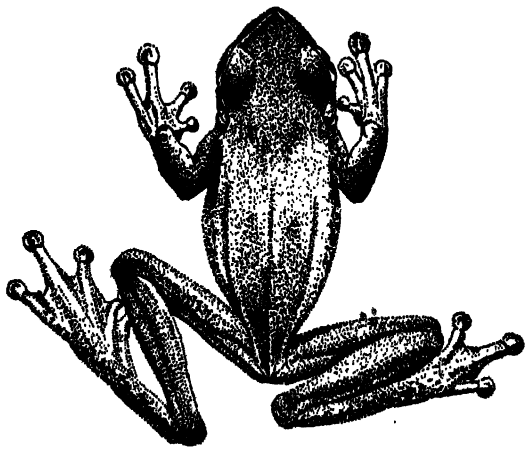

FIG. 1. *Hyla arborescandens* sp. nov. Type. ×2 EHT-HMS, No. 3135, 3 km. southwest of Acultzingo, Veracruz. Actual snout-to-vent length, 37 mm.

tibiotarsal articulation reaches slightly in advance of the eye; tympanum rather indistinct, its diameter about one third of the eye; interorbital space one third wider than eyelid; fingers about one fourth, toes a little more than two thirds webbed; subgular vocal sac; throat and chin pustular; abdomen and breast strongly areolate; dorsal surface with minute corrugations.

Description of holotype. Vomerine teeth in two raised clusters much closer to each other than to the choanae, situated between but extending a third of their length behind posterior edges of choanae; tongue broad, cordiform, nearly two thirds the width of the mouth, the surface with prominent papillae; head as broad as or a little broader than body; eyes prominent, extending beyond profile of jaw when seen from above; diameter of the eye (4.2 mm.) equal to snout, greater than distance of eye from nostril; distance between nostrils (3 mm.) less than interorbital distance (4 mm.), which is greater than the width of an eyelid (3.3 mm.); tympanum 1.3 mm. long, 1.4 mm. high, about one third diameter of eye, separated from eye by a distance (2.3 mm.) much greater than its diameter; snout (seen from above) terminating in a sharp point; a slight vertical ridge on tip of snout; loreal region subvertical, not or but slightly concave.

No trace of an axillary web; arm normal; digits with tips dilated into disks, all save those on inner finger larger than tympanum; second and fourth fingers of equal length; fingers one fifth to one fourth webbed, the webs continued as a narrow dermal fringe along the edges of fingers to disks; a large nuptual callosity, covered with minute horny spines, dark brown in color, reaches to near the disk of first finger; elongate pad on first finger nearly covered with the nuptual spinosities; two small palmar tubercles, one partly anterior to the other; outer subarticular tubercles large, flat, none divided; proximal tubercles small; supernumerary tubercles forming indefinite rows on metacarpals; a more or less continuous row of tubercles on under surface of forearm; upper surface of hand and arm with indistinct, but numerous, flat, pustular elevations. When legs are folded at right angles the heels overlap about four millimeters; disks on toes slightly smaller than those on fingers; those on three outer toes distinctly larger than tympanum; toes between two thirds and three fourths webbed, the outer webs excised to level of the median subarticular tubercle on the fourth toe; web nowhere reaches the disks save as a narrow dermal fringe; distal subarticular tubercles large, proximal ones small; supernumerary tubercles forming indistinct rows on metatarsals; a large, flattened inner metatarsal tubercle, a small indistinct outer; a tarsal fold moderately distinct; third finger only minutely longer than fifth. A moderately thick fold from behind eye above tympanum, curving down to the arm insertion; anal flap broad, somewhat thickened, with numerous grooves on its outer surface; throat pustular; breast

and abdominal surface strongly granular; sides indistinctly areolate; underside of femur with an area of large, areolate granulations intermingled with smaller granules, these reaching up on posterior part of femur to anus, where they form a transverse row of large pustules; a fold across chest.

Color. Above deep purplish lavender, gradually becoming less heavily pigmented on sides of head, body and limbs; ventral surfaces brownish-cream, with a faint scattering of pigment on abdomen and chin; ventral surfaces of heel and foot rather heavily pigmented except on inner toes; sides lightly pigmented, with a few very indefinite darker spots exposed; dorsal surface of foot with small, scattered, darker spots. (In life the color was indefinite olive, the ventral surface yellowish-cream.) Posterior side of femur lightly pigmented; a few indefinite lighter spots on dorsal surface of femur, and on sides of anus; no bands on arms or legs.

Measurement (in mm.). Snout to vent, 37; head length, 12; head width, 13; snout, 4; foreleg, 26; hand, 13; hind leg, 63; tibia, 19.5; foot, 27.

Remarks. The separation of this species from known Mexican species may be made by use of the character of the canthus rostralis combined with the large nuptual callosity and the lack of bands on hind limb. From *H. bistincta,* which has a large nuptual callosity, it may be distinguished by the absence of the very peculiar ventral prolongation of the anal flap; the presence of a well-defined outer metatarsal tubercle, and a smaller, more posterior series of vomerine teeth; from *H. plicata* by the posterior position of the vomerine teeth and the presence of a web on fingers (absent in *H. plicata*); from *H. rickardsi,* by the absence of an axillary web; from *H. taeniopus,* by the fact that the pads on outer fingers and toes are much larger than the tympanum; tongue distinctly notched behind, and a transverse fold on chest; hind limbs not barred; from *H. miotympanum* by the more posterior position of the vomerine teeth; the presence of sharp canthi, the corrugated dorsal surface, the absence of the light external stripe from elbow and heel to digits. There is no stripe on upper lip or side. (*Hyla miotympanum* has been taken in type locality of the present species.)

The type was collected at night during a downpour of rain, in a low tree, near the large spring which issues from the side of the mountain near where the highway crosses. The call was a single, rather low, mournful call, lasting about one and one-half seconds and repeated at intervals from three to four minutes. The specimen

was located only with the greatest difficulty. It was heard on the night of July 21, at which time two hours were spent trying ineffectually to locate the specimen in a low bushy tree. The following day the tree was cut down, but the frog was not found. The following night the animal was again heard, and finally located in an adjoining tree, and captured. Specimens of what I believed to be this species were heard about September 1, 1936, in the forest trees on this same mountain side, but none was captured.

Eleutherodactylus cactorum sp. nov.

(Fig. 2)

Type. EHT-HMS, No. 6383, ♀; collected, km. 226, 20 miles northwest of Tehuacán, Puebla, August 30, 1936; E. H. Taylor, collector.

Paratypes. EHT-HMS, Nos. 6376 (topotype), H. Radclyffe Roberts, September, 1936; 6382 (topotype), E. H. Taylor.

(Fig. 2)

FIG. 2. *Eleutherodactylus cactorum* sp. nov. Type. EHT, No. 6383, ♀, 20 miles northwest of Tehuacán, Puebla. Snout to vent, 77 mm.

Diagnosis. A member of the group in the genus *Eleutherodactylus* having club-shaped digits with the terminal disk lacking; the dorsal and ventral surfaces of the terminal phalanx undifferentiated from skin on remainder of digit, and lacking a trace of a transverse terminal groove; a well-defined ventral disk on abdomen. A strong fold from eye above tympanum, continuing back to groin and anus; a transverse postorbital fold; head much broader than long; eye a little longer than its distance from nostril; upper eyelid much wider than interorbital space; tibiotarsal articulation reaches tympanum; hind legs folded at right angles to the body, the heels are separated by 7.3 mm.; no trace of a tarsal fold; vomerine teeth between and behind choanae; first finger distinctly longer than second. Brownish-white with a pattern of dark lavender on dorsal surfaces; uniformly cream or yellowish on ventral surfaces.

Description of the holotype. Head much broader than long (31.5 mm.×24.9 mm.); interorbital distance distinctly less than upper eyelid (5 mm. to 8 mm.); length of eye (9 mm.) a little greater than distance from nostrils, which are situated very near extremity of snout; distance between nostrils less than their distance from eye; tympanum, 5.8 mm. high, 5 mm. long, separated from eye by a distance equal to about one third its height; tympanum partly concealed by the supra- and posttympanic folds; no canthus rostralis, the lores slightly concave, sloping obliquely to lip edge; eyes not extending beyond outline of head seen from above; tongue broad, not or but slightly nicked behind; vomerine teeth in a transverse series on raised, more or less rounded areas, situated between and partially behind choanae, separated from each other by a distance less than half their distance from choanae. (Male with a median vocal sac.) Limbs rather short, the first toe longer and much thicker than second toe, nearly as long as the third toe; subarticular tubercles on hand prominent, rounded; a large tubercle at base of first finger and a large semidivided palmar tubercle; several supernumerary tubercles on anterior part of palm; no trace of a web on hand and no lateral fringes on fingers, save a slight fold on the inner side of digits two and three; terminal phalanx of digits thickened, not or only slightly dilated; hind limbs relatively short, thick, the heels separated when adpressed; digits relatively short, the terminal phalanx not wider than digit, but thickened somewhat; third toe a little longer than fifth, which is free for a length half the free part of fourth toe; no trace of web or dermal folds on digits; tip of toes thickened, but not widened; subarticular tubercles prominent; several supernumerary tubercles on the sole, and occasional low ones between subarticular

tubercles; inner metatarsal tubercle large, about four fifths the length of first toe; outer metatarsal tubercle somewhat smaller than inner; a faint trace of a medial metatarsal tubercle; a small supernumerary tubercle lies between the anterior edges of the metatarsal tubercles.

Skin above everywhere finely and evenly corrugated, without tubercles; a strong glandular fold begins at posterior corner of the eye, passes diagonally across upper posterior edge of tympanum and is continued as a narrow skin fold to anus; a small post tympanic fold to angle of jaw; sides and ventral surfaces perfectly smooth, save for heavy granulation of the median ventral and posterior part of femur, the granulation reaching up on both sides of the median posterior groove to the anus, where the granulations become pustular; ventral disk moderately distinct.

Color in life. Ground color gray to brownish-cream with an irregular pattern of large purplish to lavender blotches, less distinct on sides; arms and legs banded with dirty cream and lavender; fingers and palm of hand cream; ventral surfaces cream with slight pigmentation on outer edges of jaws; heel and sole dim lavender; toes generally cream; posterior part of femur lavender with some darker mottling.

Remarks. The three specimens of this species were collected in large mounds formed by a species of cactus. Often the mounds would have a circumference of thirty feet, a height of two or three feet, and would contain many hundreds of the thick plants. Usually the plants or stems grow so closely together that one can scarcely find an opening large enough to insert a pencil. Occasionally rodents burrow under or gnaw a passageway beneath the mound. In this way the amphibians apparently gain entrance. When first picked up the largest female specimen uttered a curious squeal or scream (suggestive of the noise made by a frightened rabbit), and voided urine in a continuous stream. The other female behaved in much the same fashion. More than a total of twenty of these large plants were destroyed, but only two yielded specimens of the new form. Numerous specimens of insects, snakes, lizards and other frogs were taken in this same habitat.

KEY TO THE LATICEPS GROUP OF ELEUTHERODACTYLUS

A. Toes with vestige of a web; head wider than body; a sharp-edged tarsal fold. Yucatán .... *laticeps* Duméril and Bibron,

AA. Toes without vestige of a web; head not wider than body; no tarsal fold.

B. Limbs short, thick; eyelid greater than interorbital distance; tibiotarsal articulation reaches anterior edge of tympanum; when leg is folded, the heels are widely separated. Puebla; 78 mm.................. *cactorum* sp. nov.,

BB. Limbs longer; tibiotarsal articulation reaches the middle of eye or slightly farther; when limbs are folded the heels touch or overlap slightly; eyelid less than interorbital space.

C. Tympanum ⅔ to ⅘ diameter of eye; dorsal surface smooth; Texas; 90 mm. .... *latrans* Cope,

CC. Tympanum scarcely more than one half diameter of eye; Guanajuato; 75 mm. .... *augusti* Dugès.

Measurements of *Eleutherodactylus cactorum E. latrans* and *E. augusti* (in mm.)

Species	*cactorum.*	*cactorum.*	*cactorum.*	*latrans.*	*augusti.*
Number	6382	6376	6383	17755*	6378
Sex	♂	♀	♀	♀	♀
Snout to vent	67	78	77	77	75
Snout	8.2	9	9.3	11.5	11.2
Eye length	7.7	8.3	9	7.5	8.8
Eye to nostril	7.4	7.3	8	9	8.1
Interorbital width	5.5	6	5	7.4	7
Upper eyelid	7	7.3	8	6.1	8
Tympanum height and width	5.8, 5.1	6.6, 5.3	5.8, 5	6.8, 5.8	5.4, 5
Head length	22	24.8	24.9	27.3	24.2
Head width	29	30.2	31.5	30	31
Arm	39	44	44	52.4	47.5
Finger 1	11	11	11	12	10.3
Finger 2	7	8	7.1	11	8.3
Finger 3	11.8	12	12.3	15	14
Finger 4	8.5	8	9	12.7	9.2
Leg	91	93.5	92	103	109
Tibia	30	31	31	33.5	32
Foot	40	40	42	47.2	46
Tarsus	18	18	17.2	19	21
Toe 1	4.6	4.8	5	6.8	5.8
Toe 2	7.2	7.2	8	9.4	9
Toe 3	11	10.5	10.8	12.5	12.9
Toe 4	15.6	15.7	15.3	19	18.2
Toe 5	6	7	6.2	8	8

* Kansas University Museum, Birds and Mammals.

Eleutherodactylus natator sp. nov.

(Plate XXXIX, fig. 2; Pl. XL)

Type. EHT, No. 6373, ♀; Tlilapam, Veracruz, August 16, 1936; E. H. Taylor, collector.

Paratypes. EHT, Nos. 6371, 6372, 6374, 6375. Same data as type.

Diagnosis. A member of the *liohyla* group, having the toes partially webbed, with the tips of digits dilated into moderately large disks; both inner and outer metatarsal tubercles present, a tarsal fold running little more than half way to heel; eye about

equal to its distance from snout; canthus rostralis distinct; nostril a little (about ⅕) nearer median tip of snout than eye; interorbital distance less than an eyelid; first finger equal to or minutely longer than second; bluish or purplish black on posterior surface of femur, enclosing yellowish (or cream) spots and reticulations; tibiotarsal articulation reaches beyond tip of snout; vomerine teeth between inner edges, but completely behind choanae; a fold from eye to shoulder; a diagonal lateral fold beginning much behind tympanum runs half the length of body; a second lateral fold may also be present; heels overlap when adpressed. Large; maximum size known, 93 mm.

Description of the holotype. Head oval, with well-defined canthi, the lines of which, if projected, would intersect at tip of the snout; the canthal line is slightly interrupted at nostril, and the canthi are separated by a somewhat greater distance immediately in front of nostril than behind nostrils; lores shallowly concave, the sides sloping rather sharply above, then sloping more obliquely down to lip. Eyes large, projecting somewhat beyond outline of jaw (as seen from above); eye (10.2 mm.) very slightly longer than its distance to nostril; latter a half closer to tip of snout than to the eye; distance between nostrils equals interorbital distance; width of upper eyelid (8 mm.) greater than interorbital distance (7.2 mm.); tympanum height (6 mm.) greater than length (5.1 mm.), somewhat irregularly pearshaped, separated from eye by a distance of four millimeters.

Tongue large, cordiform, slightly emarginate behind; vomerine teeth in diagonal series, on a pair of triangular elevations, separated from each other posteriorly by a distance greater than that between choanae and the anterior part of the elevation; inner edges of choanae separated by a distance a fourth or fifth greater than distance between nostrils.

Foreleg moderately developed, with the fingers terminating in well-developed disks, much wider than the narrowest part of outer phalanx (2 mm. to 3.2 mm.); the merest vestige of a web between the first and second fingers, which continues as a narrow skinfold on the inner part of the second finger; between the second and third fingers even a smaller trace of a web, but a skinfold is evident on the inner edge of the third finger. A prominent tubercle at base of first finger; a large, single palmar tubercle, bifid anteriorly; metacarpal tubercles nearly obsolete (evident in young specimens); subarticular tubercles large, rounded; hind legs rather heavy, heels strongly overlapping (8 mm.); toes with well-developed terminal

pads which are greater in width than toe behind them (3.8 mm; 2.4 mm.); outer metatarsal tubercle small, rounded, opposite middle of inner tubercle, which is rather elongate (5 mm. × 2 mm.), slightly less than half the length of first toe (9.5 mm.); web between toes extends to upper edge of subarticular tubercle on the first toe; to the middle of the tubercle on outer edge of second and third toes; to posterior edge of proximal tubercle on outer edge of fourth, which is considerably in advance of this tubercle on fifth toe; a narrow dermal fringe on edges of all toes to disks; on outer side of fifth toe the fringe extends from a point some distance behind the proximal tubercle; a strong tarsal fold slightly more than half length of tarsus. Tibiotarsal articulation brought forward reaches beyond snout.

Skin rather smooth above, with some slight rugosities on the rump; an indistinct fold from eye back to shoulder; a fold from behind tympanum continues back about half way (or a little more) on side; an indistinct, broken, dorsolateral fold arises from the heavy supratympanic fold and continues back less than half the length of body. Sides of body with scattered flattened tubercles, almost granular from axilla, to a point half way back on body; chin with very indistinct granules; a slight fold on breast, representing anterior edge of the abdominal disk which is more or less distinct.

Color in life. Above, metallic, bronzy-green with a brownish-yellow, narrow, median line from snout to vent; on sides decidedly reddish in certain areas; groin yellow; upper surface of limbs same as ground color of back, save slightly more brownish, with some dull red on feet; chin, lavender-whitish; sides of abdomen pinkish; abdomen and ventral (and to some extent the anterior) part of femur washed with salmon; under surface of feet purplish; side of head purplish with a dark line on snout along the lower edge of canthus and supratympanic fold, widening and partially covering the tympanum, which is brownish; lip lighter, with dark purplish spots; arm and foot indistinctly banded. A few deep black spots on shoulder and in groin; femur and tibia dimly barred; posterior part of femur black, enclosing yellowish reticulations and spots; ventral surface of chin, breast, femur, and tibia with brownish mottling or spots.

Measurements (in mm.). Nos. 6373 ♀, 6371 ♀, 6372 ♂, respectively: Snout to vent, 93, 71.5, 42; head length, 35, 31, 18.2; head width, 35, 30.2, 16; eye, 10.2, 9.4, 5.6; eyelid, 8, 6.3, 5; interorbital width, 7.2, 5.9, 4; snout, 13, 11.3, 6; tympanum, height, length, 6 x 5.1, 4.5 x 4, 4 x 4.9; foreleg, 42, 38.2, 23.8; longest finger, 15.8, 12.2,

8; hind leg, 145, 127, 79; tibia, 48.5, 43, 28.2; foot, 66, 50, 35.5; longest toe, 28, 22, 14.

Variation. The tympanum of the male is far larger in proportion than in the female, though proportionally higher in the female.

The coloration of No. 6371 is practically identical with the type, save that the belly was yellowish rather than salmon in life, and the region below the tympanum reddish; No. 3672 was metalic bronze above, somewhat variegated with dull reddish and greenish, with the belly whitish. No. 6374, dark olive above, blackish between the eyes and on an area behind head; tubercle near ear, orange; the limbs bronze, barred with black; black and yellow on posterior side of femur.

Remarks. Save for the fact that both Dr. E. R. Dunn and Dr. Remington Kellogg* pronounced the type of *Hylodes Berkenbuschii* Peters† identical to *Liyla rugulosa* Cope‡, I would have some slight doubt as to the distinctness of this form from Peters' species, since they agree in numerous characters. The characters which seem to separate the species are the following: The nostril is not twice as far from eye as the tip of snout (about 8 mm. to eye, 6.2 mm. to tip of snout); the first finger is equal or a little longer than second (not a little shorter than second); belly nearly uniformly yellowish or salmon, lacking dark spots; in No. 6372, a specimen of comparable length (42, [43]), the hind leg is about one ninth longer.

From *E. rugulosus* (Cope) it differs in having a sharp canthus instead of no, or a very rounded, canthus; snout rather sharply, rather than bluntly rounded; a relatively longer and slenderer body and longer limbs, with the tibiotarsal articulation reaching farther; the heels barely touching, and the webbing on toes distinctly less extensive. I believe it is a very much larger species. The largest authentic *E. rugulosus* seen measures 58.5 mm. head-body length. Kellogg's (*loc. cit.*) specimen, USNM No. 16567 Orizaba, is certainly a specimen of the species here described, and probably also 71159. I suspect that the large specimen, Field Museum No. 1482 (65 mm.) from Achotal, Veracruz, listed by Kellogg (*loc. cit.*), also belongs to this form.

Rana sierramadrensis sp. nov.

(Plate XXXIX, fig. 1)

Type. EHT-HMS, No. 3963B; collected near Agua del Obispo, between Rincón and Cajones, Guerrero, July 1, 1932, E. H. Taylor.

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* Kellogg, U. S. Nat. Mus. Bull., No. 160, 1932, p. 116.

† Peters, Monatsb. Akad. Wiss. Berlin, Dec., 1869, p. 879.

‡ Cope, Proc. Amer. Philos. Soc., XI, No. 82, p. 160.

Paratypes. EHT-HMS, Nos. 3963A, topotype; 6565, about 9 km. southwest of Mazatlán, Guerrero (km. 337), July 21, 1936; 6566, near Agua del Obispo (km. 350-351), July 24, 1936; 6567, 6568, Agua del Obispo, August 1, 1936.

Diagnosis. A member of the group of the genus that includes *Rana palmipes* and *Rana zeteki*, but differing from these in having a very long hind leg, the tibiotarsal articulation reaching much beyond the snout. The toes are practically fully webbed, bearing well-developed terminal disks on the toes; dorsolateral line continuous; canthus rostralis distinct; outer metatarsal tubercle wanting.

Description of the holotype. Head generally oval, almost triangular; snout projecting considerably beyond mouth; tongue large, nearly one half total width of head, deeply notched behind and forming two rounded projections behind; vomerine teeth in two raised diagonal series, each a little larger than a choana and lying between, but almost wholly behind, the posterior borders of the choanae; maxillary teeth small, weak.

Head a little longer than wide (34.2 mm. × 31 mm.), the snout (12 mm.) as long as eye; nostril equidistant from eye and median tip of snout, the slight skinfold behind nostril terminating in a rounded bead posteriorly; nostril situated chiefly below canthus, but its upper edge tending to interrupt the continuity of the line; canthi projected forward intersect some distance anterior to the tip of the snout; width of upper eyelid (7.7 mm.) greater than interorbital distance (6 mm.); tympanum (6 mm.) separated from eye by a distance of 5 mm.

A well-defined dorsolateral fold continuous to groin; a fold, arising on the dorsolateral fold, going diagonally behind tympanum to arm insertion, more or less distinct; a short glandular fold behind jaw angle; skin more or less smooth, with a few minute, pearl-like tubercles scattered on rump (more pronounced in young).

Forelimbs moderately large, the first finger distinctly longer than second but about same length as third; the terminal disk on fingers poorly developed, scarcely wider than the digits; three large pads on the palm, all elongate, separate; subarticular tubercles prominent, that on first finger longest; a single small tubercle on each metacarpal. Hind leg very long, the tibiotarsal articulation reaching some distance (10 mm.) beyond tip of snout; an indistinct fold from the inner metatarsal tubercle back to heel; no outer metatarsal tubercle, the inner moderate, oval, a little more than one third length of the first toe; webs continued to base of disks, on all toes,

but somewhat excised between them; terminal disks distinctly wider than digits; subarticular tubercles elongate, well developed; tibia with some traces of minute glandular folds; part of posterior surface of femur strongly granulate.

Color. Above brown, becoming grayish brown on the sides, save in head region; a few indistinct darker brown spots scattered on the dorsal surface; head with an indistinct dark line from tip of snout, through eye along outer edge of the dorsolateral glandular fold; from tip of snout diagonally across upper lip to arm, a golden cream line; a few dark markings on arm suggesting transverse bands; a dark spot under forearm, and a heavy, dark lavender band on posterior side of humerus; a series of darker blotches along the ventrolateral region, bordering the lateral gray region; femur and tibia strongly banded, with scattered spots on anterior face of both, the bands on tibia reaching half way across under surface; posterior surface of femur black, with yellowish reticulations or spots; foot with transverse bands; under surface of foot dark purplish.

Measurements (in mm.). Nos. 3963B, 3963A, 6565, respectively. Snout to vent, 91, 70, 44.5; head length, 34.2, 28.5, 17.6; head width, 31, 25.2, 14; snout, 12, 10, 7.5; eye, 11.8, 8.1, 6; interorbital width, 6, 5.5, 3; tympanum, 6, 4.2, 3.1; forelimb, 50, 38, 27; hind leg, 168, 132, 69; tibia, 55, 44.5, 25.5; foot, 72, 55, 31.

Variation. The younger specimens 6665-6668 are reddish bronze above; posterior part of the dorsolateral line whitish; a broad black band from tip of snout, involving whole tympanum, continues along the upper part of side to groin; lower on side, grayish to gray-white. The line on lip especially distinct, bordered below by brown to black-brown; on abdomen and throat, cream or dirty white. The eye of the type is slightly larger than in the second specimen 3963A. This latter specimen in life had a few small olive spots on the back which are evident in the picture (plate XXXIX, fig. 1).

Remarks. This large species replaces *Rana palmipes* in the higher parts of the Sierra Madre del Sur. It is amazingly alert and makes prodigious leaps when pursued.

I have had large series of *Rana palmipes* for comparison from Veracruz and Chiapas. This species differs in having shorter legs; the tibiotarsal articulation reaching slightly beyond eye; the heels barely touching (very strongly overlapping in *R. sierramadrensis*), the skin strongly pustulous on sides and posterior part of back; the pads on the toes smaller; marked dermal fringes along edges of middle fingers; and the dorsolateral fold not continuous to groin.

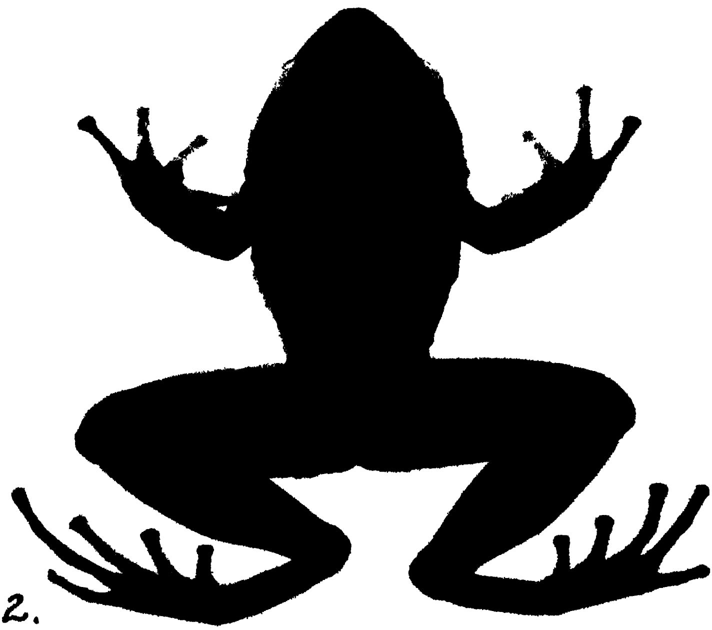
PLATE XXXIX

FIG. 1. *Rana sierramadrensis* sp. nov. Paratype: EHT-HMS, No. 3963A, Agua del Obispo, between Rincón and Cajones, Guerrero, México. Snout to vent, 70 mm.

FIG. 2. *Eleutherodactylus natator* sp. nov. Paratype EHT-HMS, No. 6371 ♀, Tililapam, Veracruz, México. Snout to vent, 71.5 mm.

PLATE XXXIX

1.



2.

PLATE XL

Eleutherodactylus natator sp. nov. Type. EHT-HMS, No. 6373 ♀, Tlilapam, Veracruz, México. Snout to vent, 93 mm.

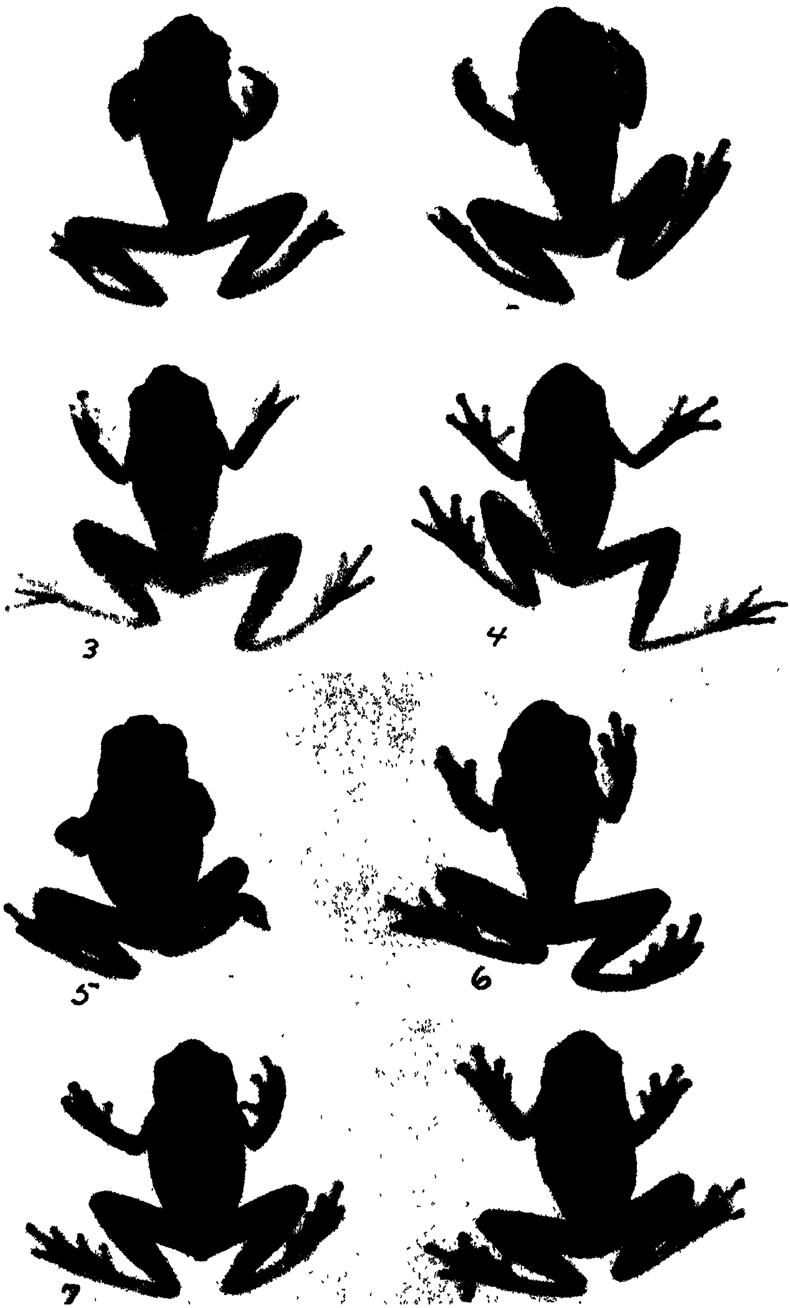
PLATE XL

PLATE XLI

Hyla rickardsi sp. nov. (about natural size).

FIG. 1. EHT-HMS, No. 1472. Paratype, near Encero, Veracruz.
FIG. 2. EHT-HMS, No. 1474. Paratype, near Encero, Veracruz.
FIG. 3. EHT-HMS, No. 5947. Type, Potrero Viejo, Veracruz.
FIG. 4. EHT-HMS, No. 5942. Paratype, Viejo, Veracruz.
FIG. 5. EHT-HMS, No. 1444. Paratype, near Encero, Veracruz.
FIG. 6. EHT-HMS, No. 1489. Paratype, near Encero, Veracruz.
FIG. 7. EHT-HMS, No. 5968. Paratype, Potrero Viejo, Veracruz.
FIG. 8. EHT-HMS, No. 5946. Paratype, Potrero Viejo, Veracruz.

PLATE XLI



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A New Anuran Amphibian from the Pliocene of Kansas

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(Plates XLII-XLV)

ABSTRACT: *Scaphiopus studeri* sp. nov. is described from the Middle Pliocene of Logan county, Kansas. It is compared in detail with *Scaphiopus bombifrons* Cope, a modern species of the genus.

DURING the summer of 1936 a fossil frog was presented to Mr. Claude Hibbard for the Museum of the University of Kansas by Mr. Frank Studer. The specimen had been obtained by Mr. Studer some time previously from a bed of diatomaceous marl located in Logan county (sec. 7, T. 11 S., R. 37 W.) about a mile east of the "Rhino Hill Quarry," which is near the east line of Wallace county.

This bed, some feet in thickness, of a gray-white color, has yielded a large number of fossil fresh-water fish, but so far as I know this is the first and only representative of any other vertebrate group that has been found.

The amphibian was obtained by cleaving a slab of marl. In doing this, portions of the skeleton remained on both sides of the slab. When first obtained the fossil was perfect, but its subsequent treatment has brought about the loss of certain of the bones, including important skull elements and the greater portion of the vertebrae. However, many of the bones are still intact and the bone impressions are relatively clear, save in the skull region.

The specimen is certainly referable to the family Scaphiopodidae, and because of its resemblance to certain modern forms I am proposing tentatively to place it in the genus *Scaphiopus*.

Scaphiopus studeri sp. nov.

Holotype. Univ. Kansas Museum of Paleontology No. 1478, consisting of a split slab of marl, each portion of which contains both imprints and bones of a single animal.

Type locality. Logan county, Kansas (sec. 7, T. 11 S., R. 37 W.), about a mile east of "Rhino Hill Quarry," near the Wallace county line.

Horizon. Diatomaceous marl, in contact with the Edson Beds, Middle Pliocene.

Diagnosis. A medium-sized *Scaphiopus* approaching the character of *Scaphiopus bombifrons* Cope more closely than any other living from; and related to *Scaphiopus pliobatrachus* Taylor, a fossil form. Spade large, tibiale and fibulare fused together at ends; sacral diapophyses fan-shaped, the sacral vertebra solidly fused to the urostyle; apparently a broad fontanelle between the frontoparietals. The ethmoid has a rounded knoblike termination. Total length, snout to vent, about 58 mm.; width of knees with limbs at right angles to body, 47 mm.

Description of the Holotype. [Photographs of the fossil remains are given (plates XLII and XLIII) and this is interpreted by a series of drawings of the individual elements (plates XLIV and XLV). I have compared these with the same elements in *Scaphiopus bombifrons* now occurring in Kansas. Some of the points of difference are worthy of note: 1st, vertebra very different in size and general character; carpalia very different; tibiale and fibulare solidly fused (not so in *bombifrons*); distal ethmoid termination not bending down, but lying in general plane of the remainder of the bone. Since the various elements of the fossil and recent forms are figured side by side, other numerous differences may be discerned, and need not be discussed here.]

SKULL

The skull is in an extremely fragmentary condition. The ventral part of the braincase is broken away, leaving the frontoparietal elements showing with a large fontanelle between them. Anteriorly a part of the ethmoid remains. It is somewhat boxlike, its anterior part enclosed, presenting at its anterior end a knoblike termination. In the character of the frontoparietals and the condition of the ethmoid this species resembles *Scaphiopus bombifrons*. In the latter the anterior projection is deflected, while in the present specimen it is straight. The nasals, turbinals, and vomers are badly shattered and the few remaining fragments tell little of the former extent of the

bones, and their relationships. A triradial fragment of the pterygoid is present, in contact with the maxillary.

No traces of vomerine teeth are discernible on the one or two fragments which may represent portions of the vomers. (Plate XLIV, fig. 2.)

Maxillary. Portions of the maxillaries are present on both sides. On the left side is a fragment measuring 5.2 mm. along the labial edge; it contains 15 teeth with one or two missing tooth spaces; on the right side the maxillary consists of four fragments which lie in a straight line (rather than curving) and show 39 teeth or tooth spaces with a total length of 9.1 mm. The maxillary shelf is at right angles to the direction of the teeth with a very slight trough standing out about six eighths mm. from the bone. The impression of the posterior extension of the maxillary shows the total length to be 10 mm., the posterior part of the bone extending out from the shaft of the quadrato-jugal to which it attaches; the greatest width (vertical) of the maxillary (2.6 mm.) is near its most anterior point. (Plate XLIV, figs. 5 and 6.)

Premaxillary. A portion of one premaxillary is present, but it has been displaced backward out of line with the maxillaries. It bears 8 teeth and two spaces. The process is missing.

Frontoparietals. These are thickened elements with a clearly defined longitudinal fontanelle between them suggesting the condition obtaining in *Scaphiopus bombifrons.* Their depth in the matrix shows a skull with considerable depth as is typical of modern *Scaphiopus.*

Parasphenoid. This element is completely shattered and only one or two small fragments are present.

Ethmoid. This element is represented by its anterior end, which is boxlike, presenting anteriorly a knoblike boss quite unlike the proboscislike termination of this element in *S. bombifrons.* Other skull elements cannot be made out in their entirety, although I believe all were present when the specimen was first obtained, with the possible exception of the mandible. (Plate XLIV, figs. 12, 13.)

THE VERTEBRAL COLUMN

The vertebral column, having a total length to end of the urostyle of 35.2 mm., consists of 9 vertebrae, with the urostyle solidly fused to the ninth (sacral) vertebra. The diapophyses are strongly dilated, fan shaped. The vertebrae from the second to the ninth are so shattered that it is difficult to interpret all the characters from the fragments and the impressions.

It is impossible to determine, beyond peradventure, the characters of the centra; however, the impression left of the ventral surfaces of the vertebrae show the suture between them curved so as to suggest strongly that most of the vertebrae are procoelous.

The first vertebra is complete, and seen from below shows two curving emarginations on the anterior upper edge of the vertebra with a v-shaped median notch. The anterior sockets for the condyles are large, and the element is strongly widened anteriorly and narrowed suddenly posteriorly. This vertebra is opisthocoelous.

The transverse process of the second vertebra is directed slightly forward; it is not or but slightly widened. The third vertebra has a transverse process distinctly wider distally than proximally, strongly compressed vertically at its proximal end; on the fourth vertebra the process is wider at the base than distally, terminating in a more or less rounded tip directed almost directly outward; its length is 4.3 mm. The fifth and sixth processes are very short, 1.2-1.4 mm. in length.

The sacral vertebra has the ventral part of the centrum shattered and missing; however, most of the urostyle is present and the greatly widened processes of the sacral vertebra. These elements are fused together. The greatest transverse width of the sacral vertebra is 10 mm.; the greatest width of the transverse process 5 mm.; the length of vertebra and urostyle (estimated) 16.3 mm. The urostyle is compressed vertically and is rounded below; it is without any ventral crest. (Plate XLIV, fig. 4.)

THE PECTORAL GIRDLE

The pectoral girdle is represented by a few fragments and impressions. The coracoid is strongly bowed ventrally and at the same time tends to curve anteriorly; the clavicle is slender and a nearly complete impression is discernible. The median point of contact of the clavicles is at their extreme tips, and there is no suggestion of an overlapping. In the case of the coracoids I can make out the median end of neither. There is no evidence of a cartilage or bone posterior to the coracoid (omosternum), but there are some bone fragments just anterior which I cannot certainly interpret. (Plate XLV, fig. 12.)

Scapula. This is discernible only as a deep depression which shows the element narrowing typically near the middle of the bone, then curving out strongly. A proximal portion of the suprascapula is present and the outline of the complete bone is shown by the impression left by the remaining part. The proximal half of the element is rectangular, but the distal part narrow and the anterior edge

of the complete element is distinctly curved, rather like the condition in modern *Scaphiopus bombifrons*.

ARM

Humerus. The humeri are more or less broken, but where broken the imprint is clear enough to show the following measurements: Total length, 16 mm. and 15.8 mm.; greatest width, 4.6 mm. and 4.8 mm.; diameter of the ball at distal end, 2.3 mm.; each of these elements has a compressed ridge or crest on its anterior half, which extends nearly two thirds the length of the bone. The diameter of the proximal head of the humerus is 3 mm. (Plate XLV, fig. 13.)

Radio-ulna. This element is now missing save for a few fragments. The impression shows a bone 10.5 mm. long (right side), 10.2 mm. (left side); each 3.5 mm. wide at the distal end.

At the distal end of the ulnar part is an epiphysis separately ossified. (It appears to be the cartilagenous element present in modern *Scaphiopus* usually so conspicuous because of its pure white color.) (Plate XLV, fig. 9.)

Carpalia. For the position of these elements, refer to the drawings. There are eight or nine of these, including the distal elements of the prepollex. The ulnare of the left hand seen from the dorsal surface is somewhat compressed. Its exposed dorsal surface shows a median groove with two ridges bordering it; the centrale is more than double the size of the ulnare, its outer face a curving surface. On the dorsal surface there is a slight depression, roughly the shape of an hour glass. The radiale is apparently missing save for a small portion of the element which presents a rounded convex surface which fits into a similar socket in the preceding carpal element. Apparently a small carpal is lost from the proximal end of the first finger; below this apparently missing element is a very tiny element imbedded in the matrix. The prepollex bone is 1.8 mm. long, and 1.15 mm. wide at the base. It narrows rapidly to a rounded point, curving slightly. (Plate XLV, figs. 3, 11.)

Measurements of metacarpals and phalanges (right). (Plate XLV, Fig. 3.)

	Metacarpal.	First phalanx.	Second phalanx.	Third phalanx.
First finger	5	0.5	0.5	. .
Second finger	4.3	1.5	0.5	...
Third finger	4.9	2.2	1.2	0.5
Fourth finger	4	1.1	0.85	0.5

THE PELVIC GIRDLE

Ilium. A portion of the ilium is present on both sides. On the right side the widened acetabular part is broken just anterior to the acetabular depression. The total length of this element is 23 millimeters to the middle of the acetabulum (estimated from the impression). At the acetabular end the bone widens. There is no knob or projecting elevation of the dorsal posterior part. The anterior ends of the ilia reach and fuse with the sacral vertebra, but do not extend to the anterior edge of the widened processes. (Plate XLIV, figs. 8, 10.)

Ischia. The right and left ischia are closely fused, and where they join with the ilium they form an elevation, when these elements are seen in profile.

Pubis. This element seems to have been at least partially of soft cartilage, for there is a discontinuity of the ventral outline of the pelvis in lateral view; no trace of a suture can be discerned to suggest fusion with ischium. It may have been normally missing or not ossified. The edges of the acetabular cup are raised on both the ischium and ilium.

Hind limb. Both hind limbs are present and all of the bones are likewise present on one or the other. The larger, thicker parts are more or less shattered. On both sides the feet are folded so as to show their ventral surfaces.

Femur. The left femur has the acetabular head complete. The greatest diameter of the head is about 2.2 mm.; the total length of the femur is 21 mm., and its greatest diameter 4.2 mm. at the distal end; it narrows to a width of 1.5 mm.; the posterior edge is slightly flattened, forming a crest (this portion is broken, but an impression of the crest can be discerned). Near the distal end is a thickened boss. (Plate XLV, fig. 2.)

Tibia-fibula. This element, somewhat broken at each end, has a total length of 18.2 mm. The arterial foramina on opposite sides of the shaft are distinct; that of the fibula one millimeter in advance of the other. No very marked grooves are visible between the fused elements, due to the shattering of portions of the exposed surface. The internal partition between the two elements is discernible at the proximal end where the bony surface is broken. (Plate XLV, fig. 10.)

Tibiale and Fibulare (astragulus and calcaneum). These two elements are present on the left side only. They are apparently completely fused together and are perfect save that a fragment is fractured from the inner distal end. It is still in place, however. The

distal width of the fused bones is 6 mm.; the proximal width, 4.6 mm.; near the proximal end of the fibulare, on its ventral surface, is a slight ridge from near the point of contact with the tibiale, to its outer edge, limiting a somewhat roughened triangular area on the ventrolateral surface. (Plate XLV, fig. 6.)

Tarsalia. Four tarsal elements, including the prehallux, are present—apparently representing the complete equipment. A small element is present at the proximal end of the first digit, and one at the proximal ends of the second and third equally in contact with both digits. The prehallux consists of an enlarged basal element from which arises a broad shovel-shaped element which originally was pressed against the ventral surface of the proximal phalanges of the first and second digits. Originally intact, this latter element has been broken, but the impression in the matrix can be seen.

The two small tarsalia (Nos. 1 and 2) are flattened, biscuit-shaped. The third may represent a fusion of two elements. The large spade (prehallux) had an original length of 4.3 mm. and a width (estimated) of about 3 mm. The sharp cutting edge (probably originally bearing horn) is evident. (Plate XLV, fig. 6.)

Metatarsals, phalanges. These elements for the most part or their clear impressions are present. Their measurements in millimeters from the first to fifth digits are given in a table.

Measurements of metatarsals and phalanges. (Plate XLV, Fig. 6.)

	Metatarsal.	First phalanx.	Second phalanx.	Third phalanx.
Right foot:				
First toe	5.6	1 7		
Second toe	8 1	2.3		
Third toe	10.1	3.6	1.7	
Fourth toe	11 5	5.2		
Fifth toe	9.3	3.6	2	0.6
Left foot:				
First toe	5.6	1.5		
Second toe	8.1	2.2		
Third toe	10.1	3.8	1.95	
Fourth toe	11.5	5 1	3	1.2
Fifth toe	9.3	3.8	2	0.6

The terminal elements vary in shape. That of the fifth toe is rather pyramidal with a slight cylindrical projection (slightly triangular in profile) from the distal end. That on the fourth finger is more curving, elongated and clawlike. The others are small, somewhat triangular, curving downward very slightly.

Remarks. The relationship of this form to *Scaphiopus pliobatrachus* Taylor from a nearby locality in the Edson Beds is discussed in a paper now in press and is not repeated here.

PLATE XLII

Scaphiopus studeri sp. nov. Type: Lower part of slab showing bones, with the exception of the feet, and tibia fibula from a dorsal view. Impressions are of the ventral surfaces of bones. Actual "head-body" length about 58 mm.

PLATE XLIII

Scaphiopus studeri sp. nov Type Upper part of slab showing bones from their ventral surfaces, the impressions from the dorsal surface.

PLATE XLIV

FIG. 1. *Scaphiopus bombifrons.* Morton county, Kansas. Ventral view of skull.

FIG. 2. *Scaphiopus studeri* sp. nov. Type: Ventral view of skull.

FIG. 3. *Scaphiopus bombifrons.* Vertebral column.

FIG. 4. *Scaphiopus studeri* sp. nov. Vertebral column. Ventral view. Length, 35.2 mm.

FIGS. 5 and 6. *Scaphiopus studeri* sp. nov. Groups of teeth much enlarged.

FIG. 7. *Scaphiopus bombifrons.* Pelvic girdle.

FIG. 8. *Scaphiopus studeri* sp. nov. Pelvic girdle length, 25.2 mm.

FIG. 9. *Scaphiopus bombifrons.* Pelvic girdle, lateral view, 22.6 mm.

FIG. 10. *Scaphiopus studeri* sp. nov. Pelvic girdle, lateral view (the posterior fragment of the pelvis shown in Fig. 8 was destroyed accidentally before the drawing of Fig. 10 was made); (length, 23 mm.).

FIG. 11. *Scaphiopus bombifrons.* Front view of skull, showing the anterior part of the ethmoid deflected downward almost in contact with the premaxillary (much enlarged).

FIG. 12. *Scaphiopus studeri* sp. nov. Portion of ethmoid as it appears *in situ* (much enlarged).

FIG. 13. Same; from a front view of its anterior end corresponding to the position of ethmoid in Fig. 11, enlarged to same scale as Fig. 12.

FIG. 14. *Scaphiopus studeri* sp. nov. Impression of the radio-ulna. Actual size, 10.5 mm. long.

FIG. 15. *Scaphiopus bombifrons.* Radio-ulna, actual size, 10 mm. long.

PLATE XLIV

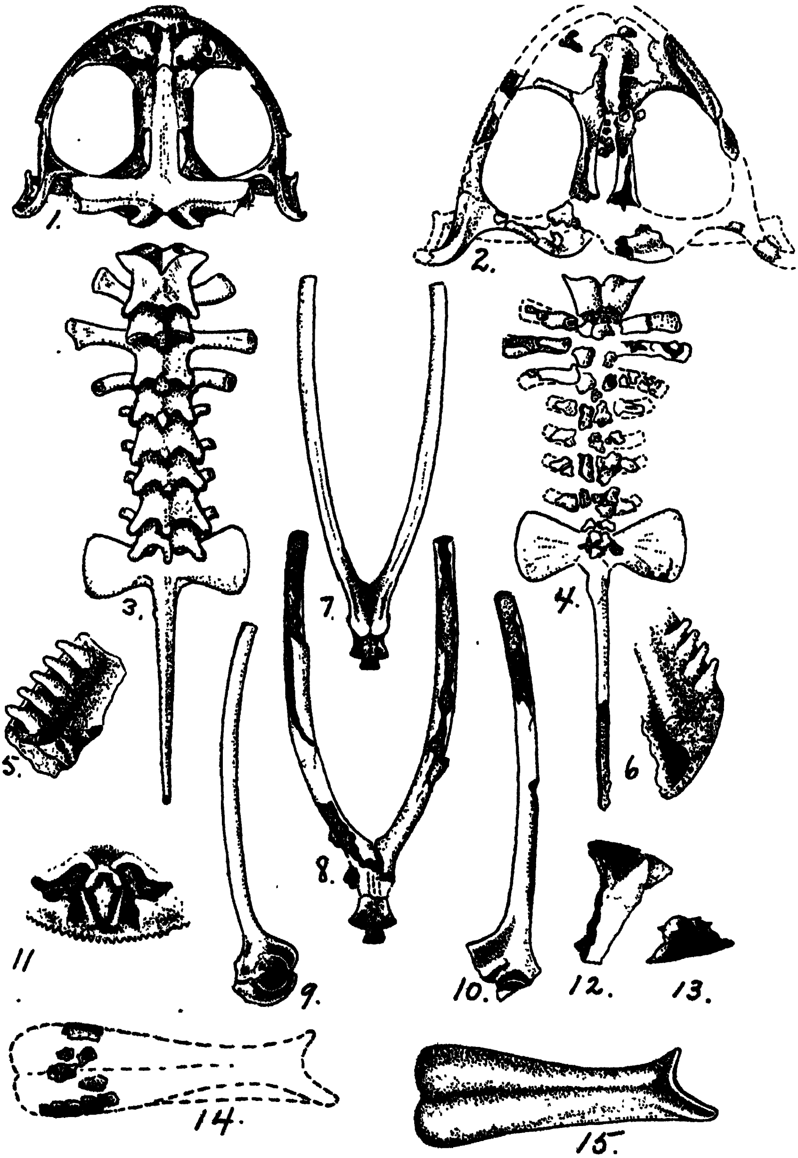


PLATE XLV

FIG. 1. *Scaphiopus bombifrons.* Femur.

FIG. 2. *Scaphiopus studeri* sp. nov. Femur (length, 21 mm.).

FIG. 3. *Scaphiopus studeri* sp. nov. Hand.

FIG. 4. *Scaphiopus bombifrons.* Hand.

FIG. 5. *Scaphiopus bombifrons.* Foot.

FIG. 6. *Scaphiopus studeri* sp. nov. Foot (length, 28 mm.).

FIG. 7. *Scaphiopus bombifrons.* Pectoral girdle from dorsal view

FIG. 8. Same ventral view.

FIG. 9. *Scaphiopus bombifrons.* Tibia-fibula.

FIG. 10. *Scaphiopus studeri* sp. nov. Tibia-fibula (length, 18.2 mm.).

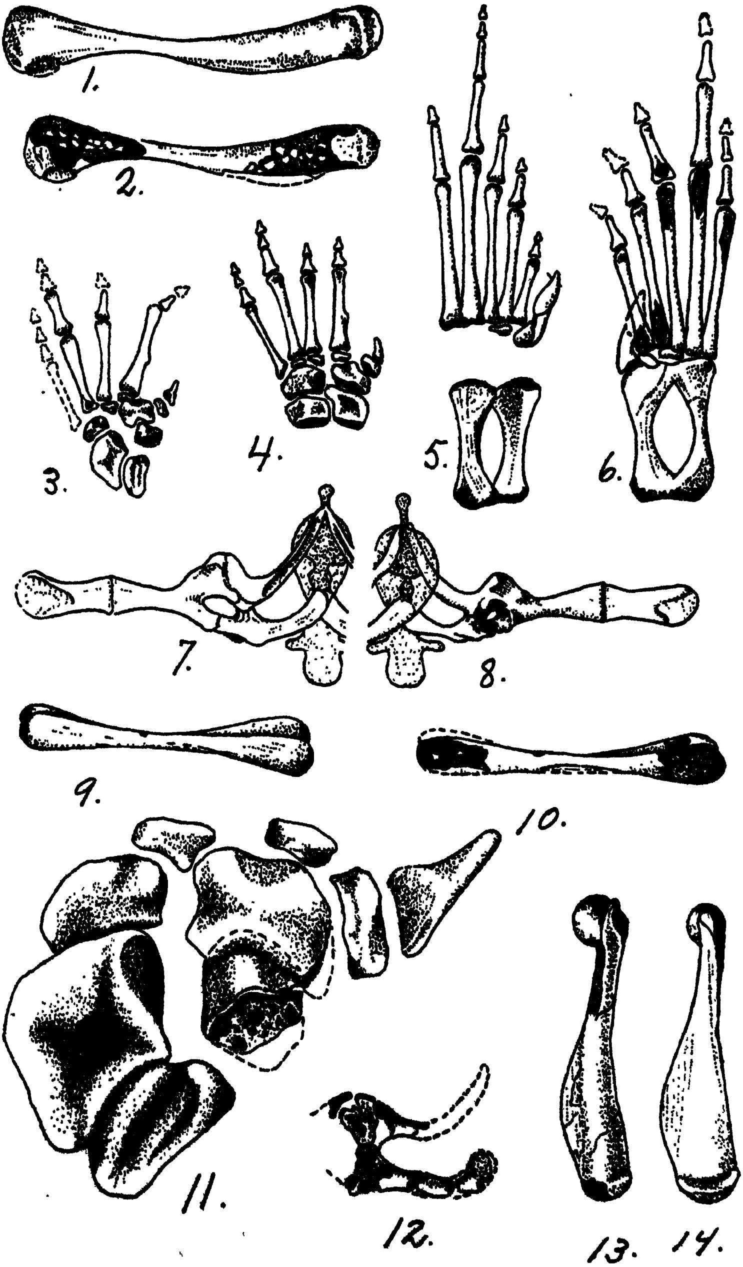
FIG. 11. *Scaphiopus studeri* sp. nov. Carpalia (greatly enlarged).

FIG. 12. *Scaphiopus studeri* sp. nov. Upper, bone, clavicle; lower, coracoid.

FIG. 13. *Scaphiopus studeri* sp. nov. Humerus (actual length, 16 mm.).

FIG. 14. *Scaphiopus bombifrons.* Humerus.

PLATE XLV



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Frogs of the *Hyla eximia* Group in Mexico, with Descriptions of Two New Species

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ABSTRACT: Six Mexican forms of the genus *Hyla* are recognized as belonging in the *eximia* group. These are *Hyla eximia* Baird; *H. euphorbiacea* Günther; *H. lafrentzi* Mertens and Wolterstorff; *H. regilla* Baird and Girard; *H. cárdenasi* sp. nov.; and *H. wrightorum* sp. nov. Cope's species *H. gracilipes* is referred to the synonym of *H. eximia*, while *H. smithii*, placed in synonymy of *eximia* by Kellogg (1932), is regarded as a good species belonging in a different group. *Hyliola bocourti* Mocquard is referred to the synonymy of *Hyla euphorbiacea* Günther.

IN MY endeavor to identify correctly a collection of Mexican Hylid frogs, I found considerable difficulty in properly allocating several forms, obviously related to the small *Hyla eximia* Baird, but which differed from this species in numerous characters. After a review of the literature (which appears to be somewhat confused), and an examination of the types of *Hyla eximia* and *H. gracilipes*, I have arrived at certain conclusions differing from those of certain former workers.

The literature offered the following names for these forms occurring in Mexico or adjoining territory (forms related so as to warrant their association into a species group which is here designated as the *eximia* group): *Hyla eximia* Baird, *Hyla euphorbiacea* Günther, *Hyla gracilipes* Cope, *Hyliola bocourti* Mocquard, *Hyla regilla* Baird and Girard and *Hyla lafrentzi* Mertens and Wolterstorff.

A critical examination of the cotypes of *Hyla gracilipes* and the cotypes of *H. eximia* shows them to belong in what I am forced to regard as a single species (*H. eximia*), since I can discern no constant structural characters or character which will serve to separate

the forms. Unfortunately most of the color characters have long since disappeared from these specimens.

The description of *Hyliola bocourti* Mocquard, based on specimens from Upper Vera Paz, Guatemala, agrees with the brief description of *Hyla euphorbiacea* to the extent that it is, at least tentatively, being placed in the synonymy of that species.

The collection made by Dr. Hobart M. Smith and myself in Mexico contains about 272 specimens of the group. This material for study has been augmented by an examination of more than 150 specimens in the National Museum, a collection of some fifteen specimens in Cornell University, and certain specimens in the collection of the University of Michigan, to the authorities and curators of which institutions my heartiest thanks are given.

This extensive material consists of six species, one of which, *Hyla regilla*, occurring in Baja California and western United States, is not considered in this paper. Three of the species are recognized under the published names *Hyla eximia, Hyla euphorbiacea,* and *Hyla lafrentzi.* Two are regarded as new, and are described under the names, *Hyla wrightorum* and *Hyla cárdenasi.*

KEY TO MEXICAN SPECIES OF THE *Hyla eximia* GROUP

A. Skin granular above or somewhat pustulate. 42 mm. Baja California and California.
Hyla regilla Baird and Girard, p. 422

AA. Skin smooth or minutely corrugate.

B. Posterior, and to a lesser extent, anterior region of the femur and groin with blackish or brownish reticulation enclosing rounded or irregular yellow-cream spots. 37 mm. Oaxaca and (? south to Guatemala).
Hyla euphorbiacea Gunther, p. 426

BB. Posterior and anterior thigh regions with sparce, equally distributed pigmentation, lacking yellow-cream spots.

C. Tibiotarsal articulation brought forward reaches to near the eye.*

D. Diameter of eye equal or greater than length of snout; snout bluntly rounded. Uniform greenish without distinct marks on side of head and body. Eyelid greater than interorbital distance. 30 mm. Puebla .... *Hyla cárdenasi* sp. nov., p. 430

DD. Diameter of eye distinctly less than length of snout; snout rather oval; distinct band on head and side, light-edged above; eyelid less than interorbital width. 35 mm. Southern México from Puebla and Morelos to Durango and ? San Luis Potosí.
Hyla eximia Baird, p. 423

CC. Tibiotarsal articulation brought forward reaches the nostril or slightly beyond the tip of snout.

D. Larger form, green with the lateral band on head and side, and spots on sacral region, edged with silvery white; the front side of the tibia blackish, bordered by a white line above, continued on foot. 50 mm. Veracruz and Morelos.
Hyla lafrentzi Mertens and Wolterstorff, p. 433

* NOTE.—If specimens are somewhat dried or shrivelled, or the body is distended with eggs, the relationship of body length to leg length (as shown by bringing the leg forward) is often difficult to determine. In such cases the tibiotarsal articulation may fail to reach as far forward as indicated in the key.

DD. Somewhat smaller form with a less-distinct band on side of body, and dorsal spots not edged with white; anterior edge of tibia with heavy brown spots, lacking a white line; webbing on toes less than *lafrentzi*. 42 mm. Chihuahua, México; New Mexico and Arizona, U. S. A. ....*Hyla wrightorum* sp. nov., p. 436

Hyla eximia Baird

(Plate LXVI, figs. 1-10; Plate XLVII, figs. 3-5)

Hyla eximia Baird, Proc. Acad. Nat. Sci. Phila., 7, 1854, p. 61 (type description; type locality, City of Mexico, Distrito Federal, Mex. Major William Rich, collector); and Rept. U. S. Mex. Boundary Survey, 2, Reptiles, 1859, p. 29, pl. 38, figs. 8-10; Peters, Monatsb. Akad. Berlin, 1869, p. 880 (*part.*); Brocchi Bull. Soc. Philos., Paris, (7), I, p. 128 (*part.*); Boulenger, Cat. Batr. Sal. British Mus., Ed. II, 1882, p. 378, (*part.*); Günther, Biologia Centrali-Americana, Reptilia, Batrachia, June, 1901, pp. 261-262, (*part.*); Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale, part 3, 2d sec. liv. 1, 1881, pp. 32-33, pl. 18, figs. 3, 4, 4a (*part.*); Cope, Bull. U. S. Nat. Mus., No. 32, p. 14 (*part.*); Nieden, Das Tierreich, Anura I, Berlin and Leipzig, 1923, p. 245 (*part.*); Kellogg, Bull. U. S. Nat. Mus., No. 160, 1932, pp. 158, 164-168 (*part.*).

Hyla gracilipes Cope, Proc. Acad. Nat. Sci. Phila., V. 17, Oct., 1865, p. 194 (type description: type locality, "Tableland northeast of the City of Mexico" [Mirador, Veracruz]); and Bull. U. S. Nat. Mus., No. 32, 1887, p. 14; Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale, part 3, 2d sec. liv. 1, 1881, pp. 36-37; Boulenger, Cat. Batr. Sal. British Mus., Ed. II, 1882, p. 378; Günther, Biologia Centrali-Americana Reptilia and Batrachia, June, 1901, p. 262; Kellogg, Bull. U. S. Nat. Mus., No. 160, 1932, pp. 153-154 and 168-170 (*part.*).

The identity of *Hyla gracilipes* Cope has been something of a puzzle. Boulenger (1882 *loc. cit.*) recognizes the form as distinct and merely copies a part of Cope's description, while Günther (June, 1901, *loc. cit.*) places the species in the synonymy of *Hyla eximia*. He comments that the statement in the description, "eyes little prominent, one half tympanic disk," is probably a *lapsus calami*.

Brocchi (*loc. cit.*) recognizes the species apparently without having specimens, and wholly on the authority of Cope *et al.*

Kellogg (*loc. cit.*) revives the name and includes the four cotypes, and nine specimens from the state of Chihuahua. He places *Hyla lafrentzi* Mertens and Wolterstorff in the synonymy of the species.

An examination of the cotypes (USNM, Nos. 15318-15321, which, according to Cope, were from "Mexican tableland northeast of the City of Mexico," and according to the USNM Catalogue, "Mirador, state of Veracruz, 1863, Carlos Sartorius, collector") shows four small specimens, so faded that practically no trace of the original coloration can be discerned, and the markings are very dim. However, the general characters of skin, body and limbs are not effaced. When compared with *H. eximia* from the type locality region I find only differences so slight that I regard them as negligible. The great length of the foot mentioned is but a trifle longer in one specimen than the normal for *H. eximia*. In all, the tympanum is only

one half (or less) than the eye, instead of the opposite (an erroneous statement given in the type description).

Another significant fact is that all are small, measuring from 28 to 33 mm. That these are adult is evidenced by the fact that two have the ovaries filled with ripe eggs. I am placing *H. gracilipes* Cope as a synonym of *H. eximia* Baird.

While *H. eximia* shows numerous variations in its wide range, it appears that these are of lesser import than would warrant even subspecific designations, at least as regards the material available to me. Specimens from Puebla in the south, with the spotting greatly reduced, compared to the heavily lined and spotted ones from Nayarit and Durango, seem superficially to be rather different from each other, but there is no sharp limit to these forms and the transition seems gradual in various populations.

The most recent treatment of *H. eximia* is that of Kellogg (*loc. cit.*). He includes *Hyla euphorbiacea* Günther and *Hyla smithii* Boulenger in the synonymy. I am commenting on the former in this paper. I have recently [Trans. Kan. Acad. Sci., 39, 1936 (July 2, 1937), pp. 357-359, pl. 2, figs. 1-5] redescribed *H. smithii*. Beyond question it is distinct from *Hyla eximia* Baird. Specimens of these forms have been examined by Mr. H. W. Parker of the British Museum and drawings made of the types of *Hyla smithii* which show the characteristic differences between the forms. *H. smithii* is related to *Hyla underwoodi* and *Hylella picta*, showing the characteristic type of pigmentation, entire lack of green coloration, larger finger pads, greater amount of webbing on the toes and feebly developed vomerine teeth. *H. smithii* has a distribution coextensive with *H. eximia* in the western part of the range, but probably occupies more territory in Guerrero and perhaps less in the eastern part of the range of *H. eximia* in Puebla and Veracruz.

The collection made by Dr. H. M. Smith and myself in Mexico totals some 245 specimens. The following localities are represented: Nos. 1840-1877, 3 km. northeast, Cholula, Puebla, July 11, 1932 (Taylor-Smith); 1881-1915A, 6 km. east, Amazoc, Puebla, July 20, 1932 (Taylor-Smith); 1916, La Colorada, Zacatecas (Smith and Dunkle), July 10, 1934; 1917-2009, 13 to 15 km. east Aguascalientes, Aguas. July 23, 1934 (Smith-Dunkle); 2010-2014, Rancho Guadelupe, 42 km. west of Toluca, México, August 4, 1932; 2015-2023, Tepic, Nayarit (Taylor); 2024-2033, near Zapotiltic, Jalisco, June 24, 1935 (Smith); 2034-2058, near Chapala, Jalisco, July 2, 1935 (Smith); 2059-2066, near Uruapan, Michoacán, July 1, 1935 (Smith); 1878, near Tierra Colorada, Veracruz, July 16, 1932

(Taylor-Smith); 1879-1880, 3 km. S. Hda. San Martín, near Zitácuaro, México, August 4, 1932 (Taylor-Smith); 5600-5603, Tepeaca, Puebla, August 12, 1936 (Taylor); 5604-5605, Hda. El Sabino, south of Uruapan, Michoacán, August 5, 1936 (Smith); 5606-5617, Uruapan, Michoacán, August 6, 1936 (Smith).

I have been able to examine a large part of the material of this group present in the United States National Museum.

Diagnosis. The smallest Mexican representative of the *eximia* group; usually some shade of green above and yellow below; dark reticulation, enclosing cream spots on posterior and anterior sides of thigh lacking; head proportionally small; a brown line from snout passes through nostril to eyes, then continues diagonally low on the side to groin, bordered above by a silver white line; lip bordered by a dark line; area between the two dark lines on the side of head, whitish, forming a stripe of irregular width to arm; front side of tibia with some dim spotting, not or rarely bordered by a whitish line on its dorsolateral surface. Trace of a web between fingers; toes about one third to two-fifths webbed; the finger pads small but distinct, one half to four fifths of the diameter of tympanum; a tarsal fold; vomerine teeth between small choanae; eyelid narrower than interorbital space; tibiotarsal articulation brought forward, reaches to some point on eye. The horny nuptual pad present on first finger a very light brown, but never a deep brown color.

Description of the species. The species is somewhat variable as regards coloration and the character of the preserving fluid tends to change somewhat the general appearance. Specimens preserved in alcohol are usually some shade of gray or ultramarine; in formalin they are often grayish-brown. Throughout its range the species tends to break up into races, some of which will doubtless be named eventually, when their ranges can be better determined. Four rather distinct varieties are discernible. These vary somewhat in size; in the size of the digital pads; the extent of the webbing on the toes; the shape of the head, and in dorsal coloration. I can discern the following varieties:

A. The typical form occurring in Puebla, Central Western Veracruz, Distrito Federal, México, and possibly also the borders of adjoining states. These are characterized by the strongly defined lateral lines; usually a pair of elongate spots in the sacral region, which may be extended forward or broken into a second pair of spots, which are white-bordered, especially on the medial edges.

B. A western striped form, best differentiated in Nayarit. In this the head is usually less pointed and the dorsal stripes are wider, often reaching forward to the eyelids; there is frequently a medial row of irregular dark

dots, and some small spots lateral to the dorsal stripes; often there is little or no green coloring anywhere on body; usually the thigh and tibia have no, or only sparse, spotting above; the range of this type includes Jalisco, Nayarit, Michoacán, and Morelos. In the latter region (Michoacán and Morelos) many of the specimens are greenish and have the area between the dorsal stripe and the lateral stripe, very light (yellowish or cream) and the medial and outer lateral rows of small spots are wanting. (See plate XLVI, figs. 1, 2, 4, 5, 9, 10.)

C. Specimens from Zacatecas and Aguascalientes have the hind limb very heavily barred with brown dorsally. They are somewhat smaller, but have much of the general appearance of the typical specimens. Sometimes, however, the stripes reach the eyelids and certain ones show spots lateral to the dorsal stripes (See plate XLVI, figs. 3, 6, 7, 8.)

D. The most striking variant is represented by two specimens from Durango (USNM, No. 14083). These have a brownish ground color; one has large, irregular, deep-brown spots covering the dorsal surface of the body and limbs; the other a pair of curving shoulder spots with other scattered spots and fine scattered flecks over the dorsal surfaces of the body. These specimens are badly shrivelled; however, the pads on fingers are distinctly larger than those on specimens from Nayarit.

These variants appear different to the eye. However, with the study of the material available to me I am unable to make a satisfactory separation of these variant forms into groups that warrant subspecific designation.

All seem to agree on having small choanae; relatively large groups of vomerine teeth, and the same essential color pattern on sides of head and body.

The figures given by Baird, United States and Mexican Boundary Survey (plate 38, figs. 8-10) are poor for detail, especially as regards the markings on the side of the head, the general characters of the roof of the mouth and the characters of the pads; and the general habitus of the body (in fig. 8).

I am at a loss to account for the apparent absence of *H. eximia* from Guerrero. Kellogg (*loc. cit.*) lists specimens collected by Hans Gadow from Tacubaya, Guerrero. Since the postal directories of 1892 fail to list such a locality for Guerrero, I suspect that the state is incorrect. This name occurs in Distrito Federal, where Gadow collected, as well as in certain other states which I believe he did not visit. (Tamaulipas, Campeche, Yucatán, Tabasco).

Hyla euphorbiacea Günther

Hyla euphorbiacea Günther, Cat. Batr. Sal. British Mus., Feb. 12, 1859, p. 109, pl. X, fig. C (type description; type locality, Córdova [Veracruz]; Cordilleras [of México?] and México, four specimens and a skeleton).

Hyla eximia ? Peters, Monatsb. Akad. Wiss. Berlin, 1869, p. 880 (*part.*). (It is possible that all the specimens mentioned are true *H. eximia*. However, *H. euphorbiacea* is placed in

synonymy.) Boulenger, Cat. Batr. Sal. S. Ecuad. British Mus., 2d Ed. 1882 (*part.*, specimens, types of *H. euphorbiacea*); Günther, Biologia Centrali-Americana. Rept. Batr; June, 1901, p. 261-262 (*part.*) Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale, pt. 3, 2d section, livr. 1, 1881, pp. 32-33 (*part.*); Kellogg, Bull. U. S. Nat. Mus., No. 160, 1932, pp. 164-167 (*part.*) (all or part of the Oaxaca specimens—certainly USNM. No. 47908).

? *Hyliola bocourti* Mocquard, Nouv. Arch. Mus., (4) T. 1, 1899, pp. 341-342 (type description; type locality, "Haute Vera Paz," Guatemala; maximum length, 40 mm.; the posterior face of the thigh is brown with yellowish white spots).

A series of nine small hylid frogs collected by Dr. Hobart M. Smith near the city of Oaxaca make evident the necessity of reviving the name *Hyla euphorbiacea* Günther. These specimens agree with Günther's brief description and figure. While obviously of the *eximia* group, and related to *Hyla eximia*, they differ from this species in the pigmentation and coloration of the posterior femoral regions, and somewhat greater webbing of the toe, and in having a broader head. *Hyla regilla* listed by Brocchi (*loc. cit.*), plate XIII, figs. 2, 2a, cannot be *H. bocourti* (*euphorbiaecea*), since the dorsal coloration and the posterior thigh coloration shown is different from that given in Mocquard's description of *Hyliola bocourti*. Figure 3 of this same plate is labeled *Hyla eximia* var. *euphorbiacea*. This is a specimen lacking black lines on the back and may or may not be *Hyla euphorbiacea*, since certain *eximia* lack evidence of these spots or lines, and they are frequently present in *euphorbiacea*.

Hyla bocourti Mocquard, Bull. Soc. Philom., Paris, (9) T. 1, 15, is very probably a true *Hyla eximia* of the Tepic form shown in this paper (plate XLVI, figs. 1, 2, 4, 5).

Diagnosis. A member of the *eximia* group, related to *Hyla eximia* Baird, but somewhat larger with a broader head and the posterior part of the femur strongly marked with blackish pigment enclosing round or irregular cream markings. Upper labial edge dark gray, bordered by a cream line; greenish, or grayish-green above with elongate spots which may be absent or obscured; vestige of web between the fingers, with traces of dermal fringes on fingers; toes with webs extending about a third of their length, with strong dermal fringes; a well-defined tarsal fold; a large inner and smaller outer metatarsal tubercle; largest disks on fingers about two thirds to three fourths the area of the tympanum; a fold on breast. Male with vocal sac; tibiotarsal articulation reaches to about middle of eye; length of eye slightly longer than its distance from the nostril, one fourth shorter than length of snout; interorbital width about one third greater than width of upper eyelid; vomerine teeth in two slightly diagonal series between the choanae.

Description of the species. (From EHT-HMS, No. 3134, near

Oaxaca, Oaxaca, México, August 4, 1935. Hobart Smith, collector; one of a series of 9 specimens.) Top of head nearly flat; the depth at tympanum, 4.5 mm., at nostril, 3.2; eyes moderate, projecting somewhat, their length a little greater than distance to nostril, but much shorter than snout; tympanum rather distinct, its diameter a little greater than half the length of eye opening; upper eyelid about two thirds as wide as interorbital distance; snout projecting moderately beyond mouth. Canthus rostralis more or less distinct, rounded or slightly angulate, the loreal region strongly oblique, not or slightly concave; vomerine teeth in two groups more or less closely approximated, lying between the large choanae, separated from them by a distance slightly less than length of a single group; tongue nearly circular, slightly notched behind, free for a little more than one fourth its length; a large median vocal sac; skin above and on sides smooth; abdomen and most of ventral surface of the femur with large granules; chin with very minute granules; breast nearly smooth, the granulation can scarcely be discerned; a part of the posterior part of femoral region granulate; arm with a few granules or tubercles on the ventral surface; fingers with well-developed disks, that on first finger small, scarcely wider than digit; that on third finger more than two thirds size of tympanum; first finger reaching a little beyond the subarticular tubercle of the second; latter reaches the disk of fourth; the fourth reaches the disk of third; a vestigial web between the fingers and a trace of a dermal fringe on sides of digits; inner palmar tubercle large, prominent, rounded anteriorly; median and outer partly confluent, forming a large tripartite pad; subarticular tubercles, large, rounded, save the proximal tubercles on two outer fingers, which are scarcely larger than supernumerary tubercles on palm; hand, to tarso-metatarsal joint, shorter than the tibia; when limbs are folded at right angles to body axis the heels overlap about one millimeter. Inner metatarsal tubercle large, salient, its length in its distance from tip of first finger about 2.5 times; toes about one-third webbed, the webbing extending to or a little beyond the second subarticular tubercle on the three outer toes, to the single subarticular tubercle on the first and second; well-defined dermal fringes on toes extending to the disks.

Color. Above green (silvery gray in alcohol) with two elongate, irregular dark blotches beginning about middle of body and extending to groin; a dark narrow black bar extends from snout through nostril to eye, silver-edged above; a broad, dark-blackish stripe. silver-edged above, begins behind eye, including most of the tympa-

num, then passes above arm; it then turns down, passing along the sides of body, rising again posteriorly; the lower part of the stripe is grayish posteriorly on its lower side and fades to a lighter shade toward the ventral surface; a few small, indefinite, lighter spots on sides; two or three larger yellowish spots in groin; upper lip bordered with a narrow gray line continuous in front and bordered above with a narrow cream or silvery line which is scarcely distinguishable from the lighter area in the loreal region, which continues back a little distance behind the angle of the jaws; outer edge of arm with a light-edged, broad, dark stripe; an irregular darker blotch on hand; palm lacking pigment; a dim darker bar crosses femur distally; one or two similar bars on tibia; anterior surface of femur with a dim dark stripe, light-edged above; a large blotch on foot near heel; underside of foot and heel with some dark pigment; chin and other ventral surfaces creamy white (vocal sac more or less darkened in males); the posterior and anterior surface of femur blackish or brownish with well-defined yellow-cream spots, round or irregular in shape; the front side of the arm with none, or only very dim, markings.

Measurements of *Hyla euphorbiacea* Günther

Number	3126	USNM 47908	3133	3134
Sex	♂	♂	♂	♀
Snout to vent	35	37	32.2	33
Head length to angle of jaw	10	11.5	10	10
Head width, greatest	12.2	12.9	10.7	10.5
Diameter of eye	2.5	4	3.5	3.6
Diameter of tympanum	2.1	2.2	2.1	1.8
Length of snout	4.9	5	4.4	4.4
Interorbital distance	3.65	3.8	3	2.9
Upper eyelid	2.8	2.4	2.5	2.4
Arm	20.2	21.5	19.8	20
Hand and longest finger	9.9	11	8.6	9.1
Leg	55	60	51.5	50
Tibia	16.6	19	15.2	14.2
Foot and tarsus	25	27	23.2	22.3
Largest finger pad	1.9	2	1.5	1.3

Variation. The series of ten specimens vary in the presence of visible dark spots on the sacral region. In some they are totally obscured, in others they may be more distinct and there may be one or more small spots farther anteriorly; the loreal region below the

black bar, and the region under eye and in front of tympanum may be lighter or darker, but posteriorly the light color is prominent and strongly delimited by darker color. The groups of vomerine teeth vary in their proximity, sometimes being closely approximated, in others rather widely separated; usually they reach both anterior and posterior level of choanae.

Remarks. This lot of specimens was collected by Hobart M. Smith, very near the city of Oaxaca, Oaxaca. In his diary he states: "This hyla has a different call from *H. eximia.* The green color on the back is about the shade of that in the leaves of a water lily. The dark stripe on the side is brownish. The groin and concealed surfaces of the femur and tibia are, in the lighter areas, yellowish with a fine brownish reticulation. The vocal sac of the male is light yellow with fine brown stippling. One copulating pair was taken. They were extremely wary and were captured with difficulty. All were captured in a rain pool in a cornfield."

This species differs from the typical *H. eximia* in having a somewhat larger size, and broader head; slightly more elongate fingers, with the vestigial web more pronounced and with somewhat larger disks; the webbing extends a slightly greater distance on the toes, and the posterior coloration of the thigh is wholly different.

Günther states: "M. Sallé generally found it resting on the large euphorbiaceous plants."

Hyla cárdenasi sp. nov.

(Plate XLVII; fig. 2)

Holotype. USNM, No. 84403, Puebla, Puebla, Méxicó, September, 1919. H. Ruano, collector. (Field No. 3, Comision Geografica Exploradora de México.)

Paratype. EHT-HMS, No. 3963, near Río Frio, México, July 31, 1932, E. H. Taylor, collector.

Diagnosis. A member of the *eximia* group. Eyelid wider than the interorbital distance; eye longer than snout in adult; tympanum more than half diameter of eye; head wider than long; diameter of largest finger pads slightly greater than half the diameter of the tympanum; pads subtruncate; web rudiment between first three fingers, none between outer fingers; a thick, well-defined tibiotarsal fold; when limbs are folded, heels touch; tibiotarsal articulation reaches slightly in front of eye; tongue with fine raised papillae; vomerine teeth in two small groups close together, lying directly between choanae, but separated from them by a distance greater than a single group.

Description of type. Head very short, the snout as deep as its length or approximately so, extending somewhat beyond mouth; length of the snout distinctly shorter than length of eye; eyelids distinctly wider than interorbital distance; diameter of tympanum more than half the length of the eye; distance between nostrils equals distance from eye to nostril; tympanum separated from eye by a distance equal to three fourths its diameter; tongue subcircular, very slightly emarginate behind, covered with numerous salient papillae; choanae moderately large, separated by a distance greater than that between nostrils, but not greater than distance between outer edges of nostrils; groups of vomerine teeth rather narrowly separated, about size of choanae, not reaching anterior level of choanae, but extending half their length behind hinder level; skin of dorsal surface quite smooth, on sides growing somewhat pustulate or granulate toward ventral surface; chin and throat with small indistinct granules; remainder of the ventral surface of the body strongly granulate, the granules unequal in size; most of proximal half of ventral surface of femur strongly granulate; distal half smooth; a few enlarged granules below anus, the median ones bordering a distinct groove; some indistinct granules on the ventral surface of arm; a thick fold behind eye covering upper edge of the tympanum and extending back toward arm insertion, not folding down behind tympanum; an area of thickened skin somewhat back of the angle of the jaw.

Tips of fingers strongly dilated, the tips more or less truncate, the essential portion of the pad (anterior to groove) practically twice as wide as deep, the free edge of skin above the tip scarcely evident; a mere vestige of a web between first three fingers; scarcely or not indicated between the two outer fingers; the diameter of the largest pad on fingers as great as that of tympanum, but area is smaller than area of tympanum; distal subarticular tubercles large, rounded, not divided; numerous supernumerary tubercles on palmar surface. A large flat tubercle on ventral surface of the base of the first finger, and a large flattened palmar tubercle, partially divided anteriorly, on posterior part of palm; narrow more or less continuous skin folds on outer edges of fingers, not or scarcely indicated on inner edges; no fold on ventral surface of forearm; tibiotarsal articulation reaching to about anterior edge of eye; a well-defined tarsal fold becoming thickened posteriorly. Toes about one-third webbed, the web continued on sides of toes as a narrow fringe, save there is none on outer edge of outer toe; terminal disks smaller than on fingers, the essential pad nearly twice as wide as long, the tips

rather truncate; all subarticular tubercles well developed, the distal ones not noticeably larger than the proximal ones; supernumerary tubercles on fingers low, rather indistinct; a strong oval, inner metatarsal tubercle; a small indistinct outer tubercle anterior to level of the anterior edge of inner.

Color in alcohol. Above a uniform purplish or lavender-gray (probably a shade of green in life) with no evidence of darker markings; no trace of a light line from eye along side; upper lip scarcely lighter than remainder of side of head and no light mark continued to arm from eye; lighter about insertion of arm; no light mark above anus; posterior surface of femur heavily stippled or powdered with brown; chin of female heavily pigmented; ventral surfaces of hands lacking pigment; feet with some pigment; ventral surface of body dirty-white, lacking pigment.

Measurements in mm. of the type and paratype of Hyla cárdenasi USNM, No. 84403, and EHT-HMS, No. 3963, respectively: Snout to vent, 39, 22; head length to jaw angle, 12, 8.2; head, greatest width, 14, 8.2; diameter of eye, 5, 3; length of snout, medial, 4, 3.4; depth of snout in front of eye, 4.1, 3.2; diameter of tympanum, 2.6, 1.6; interorbital width, 3.4, 2; upper eyelid, 3.4, 2; arm, 23.7, 12.2; width largest finger pad, 2.5, 0.9; length of leg, 67, 35; tibia, 21, 11; foot and toes, 30, 15.2; largest toe pad, 1.5, 0.9.

Variations. The paratype is a young specimen. It will be noted from the dimensions presented that the proportions vary between young and old, the head being proportionally narrower and the limbs proportionally different from those of the adult. The skin is thickened, minutely corrugated. In life the color was a deep bluish-green; in preservative it is ultramarine.

Remarks. The paratype was collected in the pine forest near Rio Frio, México, at an elevation of about 3,000 meters. It was hopping about on the forest floor. The type is an adult female, the ovaries filled with large eggs.

The relationship of the species appears to be closest to *Hyla lafrentzi,* from which it differs in the details of markings; in lacking the pronounced dark and white lines on the side of the head and body; in the somewhat wider and more truncate pads on the fingers; in having a shorter, thicker snout; and in the heavy pigmentation of the throat of the female. Other differences are evident on a comparison of the descriptions and figures.

In size the species is intermediate between *eximia* and *lafrentzi.*

The species is named for General Lazaro Cárdenas, president of the Republic of Mexico.

Hyla lafrentzi Mertens and Wolterstorff.

(Plate XLVIII; figs. 1, 2)

Hyla lafrentzi Mertens and Wolterstorff, Zoöl. Anz., B. 84, No. 9/10, August 25, 1929, pp. 235-241 (type description; type locality, Desierto de los Leones, in mountain forest, 3,000 meters elevation, near Mexico City, Distrito Federal. Type in Magdeburg Mus. No. 49/27; K. Lafrentz, collector, December 18, 1927); Lafrentz, Blatt. Aquar-Terrar. Kunde, 38, 1927, p. 322.

Hyla gracilipes Kellogg, Bull. U. S. Nat. Mus., No. 160, 1932, pp 153-154, 168-170 (*part.*).

This species is represented in the collection by EHT-HMS, Nos. 3958A, 3959-3962, near Vigas, Veracruz, México, July 13, 1932, Taylor and Smith, collectors; and Nos. 5978-5991, Lake Zempoala, near Tres Marias (Tres Cumbres), Morelos, 3,300 meters elevation. (Lake Zempoala is about thirty kilometers from the type locality.) I have examined two Michigan Museum specimens, Nos. 5304 and 48065, Guerrero, Hidalgo.

Diagnosis. The largest species of the *H. eximia* group, attaining a known maximum size of 50 mm. head-body length; a vestigial web between fingers; toes between one half and two thirds webbed; fingers and toes with rather small terminal disks, those of fingers the larger; those of outer fingers about half the area of the tympanum; large nuptual callosity at base of first finger, covered with a deep brown horny excrescence in males; tympanum one half to two thirds the length of the eye; eye somewhat shorter than the snout, the interorbital space somewhat wider than upper eyelid; tibiotarsal articulation reaches tip of snout or somewhat beyond; a distinct tarsal fold. Greenish above, the ventral surfaces yellowish, save the chin may be dark in males; paired black spots edged with white on sacral region and a dark blackish streak through eye to side, edged above with white.

Description of species (from EHT-HMS, No. 1814, collected near Vigas, Veracruz, July 13, 1932). Head rather thickened with a depth at jaw angle of 6.5 mm., sloping forward to nostril, where the depth is 3.8 mm., then sloping abruptly down to the mouth; the snout very slightly rounded, in lateral profile, and projecting slightly beyond mouth; canthus rostralis distinct to nostril, slightly rounded rather than angulate; eye moderately prominent; the interorbital width slightly less than width of an upper eyelid; length of eye less than the length of snout; nostril nearer the eye than to the median anterior edge of mouth; tympanum rather large, its diameter a little more than half the length of the eye; pupil of eye horizontal; loreal region sloping obliquely to mouth, slightly concave, the lines of the canthus nearly straight, when extended intersecting at tip of snout or slightly beyond.

Vomerine teeth in two rather small, somewhat conical groups, lying wholly between the choanae, separated by a narrow distance, and separated from the choanae by a distance slightly less than width of a single group; choanae smaller than a single tooth group; tongue subcircular, large, emarginate posteriorly, free for a little less than one third its length; vocal sac medial, single, evident on chin by ample folding of the skin, its elongate openings lying lateral to the posterior part of tongue.

A well-defined supratympanic fold, overhanging the tympanum somewhat, runs back and down to a point somewhat back of the insertion of the forearm; a glandular area behind the angle of the jaws which is rounded on the posterior border; an indefinite glandular area on anterior proximal portion of upper arm. The skin above is practically smooth (minutely corrugate); sides indistinctly granular or areolate, becoming more distinctly granular low on sides; entire abdomen and underside of thigh (largely) with large distinct granules, while those on breast and distended membranes of the throat, smaller, with still smaller intercalated granules; a heavy skin fold across the pectoral region, in which the granules are less distinct; anal region granular; underside of arm granulate, but remainder quite smooth; skin glandular in the supranal region.

A distinct vestige of a web is present between the fingers, and evidence of a thickened dermal fringe on edges of digits extending to the disks. Disks distinct, rounded, that on the third finger largest, about one half the area of the tympanum, that on first finger distinct, but scarcely wider than digit; a large nuptual callosity on inner side of first finger extending to the disk, covered with a dark horny excrescence (perhaps present only during breeding season). A very large palmar tubercle present on base of first finger, its inner outline obscured by the nuptual callosity; medial and outer palmar tubercles confluent posteriorly, separated by a groove anteriorly; subarticular tubercles large; surface of palm with large, irregular granules or tubercles; foot moderately elongate, the part from the tarso-metatarsal articulation to tip of longest toe a little shorter than tibia; a large inner metatarsal tubercle, its length contained in its distance to tip of first toe one and two thirds times; outer metatarsal tubercle small, rather indistinct. Toes somewhat more than half webbed, the webs continued to the terminal disks as narrow, thickened dermal fringes; the proximal subarticular tubercles on the two outer toes small, others large; foot with numerous indistinct subarticular tubercles; a clearly-defined tarsal fold; the

dermal fringe on the fourth toe continued a little behind proximal subarticular tubercle.

Color in life. Upper parts dark green to olive-green, somewhat lighter on the sides (bluish in alcohol). A dark bar from nostril to eye and a dark grayish line bordering the lip, darkest on its upper edge, and bordered above by a cream line, which terminates below angle of jaw; a more or less dense black stripe, edged above with cream, runs from eye along the supratympanic fold, and is continued on the side of the body as a very narrow, scarcely discernible, dark line to groin, delimiting the greenish color of back and sides.

A pair of dark, light-edged spots on the posterior third of the body, with two or three spots on back between femora; a single indistinct dark spot on distal surface of femur; a narrow, light-edged, dark line on outer (anterior) face of tibia, and a similar line on outer (posterior) edge of the tarsus, continued along outer toe; the dark line merges into the coloration below it; glands above anus, cream; posterior surface of femur and concealed part of tibia with a sparse, uniform peppering of black; a few indistinct darker flecks on toes; ventral coloration cream to flesh, the vocal sac grayish-purple with the granules cream; ventral surface of foot sparsely pigmented; a dark line with a light border above on outer side of arm and hand.

Measurements (in mm.) of *Hyla lafrentzi* Mertens and Wolterstorff

Number	5980	5984	5986	5978	5991	3960
Sex	♀	♀	♂	♂	♂	♂
Snout to vent	50	44	41 2	43.2	40	39
Snout to eye	5 5	5 2	5 9	5.8	5.6	5.5
Head length to angle of jaw	15	14.6	13 2	13	12	12.3
Head width, greatest	15.9	15.2	15	14.6	13	14.1
Diameter of eye	5	4.7	4	4 3	4.1	4
Diameter of tympanum	3	3	2.6	2 85	2 35	2.3
Eye to nostril	3.5	3.7	3 35	3 6	3.1	3.3
Depth of head in front of eye	4.7	4 5	4 5	4 5	4 5	4.4
Heels overlap	3.7	3	3.5	2.7	2.5	3
Arm	29.2	28	23	23.6	24.6	24.5
Hand	15	12.1	12.1	12.1	12.3	11 6
Leg	85	75.5	68	68 3	67.5	64
Tibia	27.2	23	22	21.5	21	20.2
Foot and tarsus	37.1	33.5	32	31	29	28.9

Variation. Specimens from Lake Zempoala, Morelos, from a higher elevation show a slight difference in the depth of the head, and the tip of the snout is slightly more elongated.

Remarks. The specimens collected near Vigas, Veracruz, were found about a small rain pool beside the highway during the morning. The males were calling. Those taken at Zempoala were calling most of the day. A single pair was found clasping. A few immature tadpoles, presumably of this species, were found in small pools in the bog near the lake edge.

While this species resembles certain specimens of *Hyla eximia* in general characteristics, its much greater length and bulk, the longer legs, proportionally wider head, and the fact that the range of *H. lafrentzi* is within that of *H. eximia,* should preclude the possibility of their being regarded as the same species.

Hyla wrightorum sp. nov.

(Plate XLVII, fig. 1.)

Hyla eximia Yarrow, Bull. U. S. Nat. Mus., No. 24, 1882 (*part.*) (specimens from New Mexico); King, Copeia, 1932, No. 2, p. 99 (Mormon Lake, Arizona); Wright and Wright, Handbook of Frogs and Toads, Ithaca, N. Y., 1933, pp. 118-119, plate XLIII (an excellent series of photographs of live specimens with a description, and notes on voice, breeding, and habits (Texas, New Mexico, Arizona); Stejneger and Barbour, Check List North Amer. Amph. Rept., 3d Ed., 1933, pp. 34, 35 (*part.*).

Hyla gracilipes Kellogg, Bull. U. S. Nat. Mus., No. 160, pp. 154, 168-170 (*part.*) (specimens listed from Chihuahua); Stejneger and Barbour, Check List North Amer. Amph. Rept., 3d Ed., 1933, p. 35 (*part.*).

Holotype. No. 79141, Museum of Zoölogy, University of Michigan. Eleven miles south of Springerville, Apache county, Arizona, U. S. A.

Paratypes. USNM, Nos. 26605-26609, Meadow Valley, Chihuahua, Mexico; USNM, No. 9338 (2 specimens), Santa Fe, New Mexico, U. S. A.; MUMZ, Nos. 79141, 3 specimens; 11 miles south of Springerville, Apache county, Arizona, August 13, 1935; 79143, 4 specimens; David Lee Lake, southwest of Luna, Catron county, New Mexico, August 6, 1935, 8,000 feet; 79142, 3 specimens; 26 miles north of Luna, Catron county, New Mexico, 8,100 feet, July 31, 1935; 75734, 1½ miles northwest of Miller's peak, Huachuca mountains, Arizona, August 16, 1933.

Diagnosis. A member of the *Hyla eximia* group, but differs from typical *H. eximia* in a larger size, longer legs, the heels overlapping one or two millimeters when limbs are folded at right angles to the body; the tibiotarsal articulation reaches the tip of snout or slightly beyond; the head is less pointed, and proportionally wider; the first finger is proportionally longer. The posterior half (or more) of the edge of the lower jaw is darkly pigmented; the posterior side of femur lightly and evenly pigmented.

Description of the type. A medium-sized member of the *Hyla eximia* group. The snout is rather truncate or bluntly conical, with the canthi more or less distinct but rounded; the line between eye and nostril somewhat concave, sloping obliquely from canthus to edge of lip; diameter of eye somewhat greater than distance of eye to nostril, and equal to distance of nostril to middle of upper labial border; nostrils below edge of canthus, the distance between them about equal to their distance from eye; the area about nostril slightly elevated, and a slight, shallow groove present between nostrils; diameter of the tympanum is contained in the diameter of the eye slightly more than 1.5 times; the distance between the tympanum and eye about .65 of diameter of tympanum.

Tongue broadly cordiform or subcircular with a very slight median emargination posteriorly; free posteriorly for two fifths of its length. In males the openings of the single vocal sac are lateral to the tongue and much elongate; tongue papillae not prominent; the raised prominences bearing the vomerine teeth are large, placed slightly diagonally and closer to each other than to choanae; they arise near anterior level of the choanae, but do not reach their posterior level. The openings of the mucous glands form a continuous groove anterior to choanae; latter proportionally large.

A vestige of a web between first three fingers, but practically obsolete between outer fingers; disks on the fingers moderate, only a little wider than the toes, the widest one on outer fingers equal in width to a little more than half the diameter of tympanum; first finger reaching to a point halfway between the distal subarticular tubercle and the terminal disk of the second; the distal subarticular tubercles large, that on outer finger very slightly bifid on right side (probably abnormally); a slight dermal fringe on the lateral edges of fingers; fourth finger longer than second.

Legs elongate, the limb laid forward, the tibiotarsal articulation reaches to the tip of the snout or beyond slightly; when limbs are folded at right angles to body the heels overlap about two millimeters; terminal disks on toes not wider than digits, distinctly smaller than finger disks; a well-defined tarsal fold; a prominent, salient, inner metatarsal tubercle, its length in the first finger length about two and one-half times; outer metatarsal tubercle distinct, flattened, lying behind the anterior level of the inner tubercle; inner toes webbed at base, the depth of web from one fourth to one third the length of the outer toes; the web between the three outer toes incised to a point one third the distance between the two

proximal subarticular tubercles of the fourth toe; supernumerary tubercles on palm and foot more or less distinct. (In males the large tubercle at the inner part of the base of first finger is covered with a corneous callosity, usually very light brown in color.) Anal flap rather wide, not especially modified; no axillary web; skin on body relatively smooth, under magnification one observes minute corrugations, more evident above eyes; a strong skin-fold across the breast; ventral surface granulate, the granules on the anterior part of abdomen largest, less distinct on throat and chin; granulations prominent on median ventral, and to some extent, posterior part of thighs; a rather thick but relatively indistinct fold above tympanum.

Color in alcohol. Above, on limbs and body, grayish-lavender (probably some shade of green in life); two rather large and several smaller spots in sacral region; a narrow brownish line begins near tip of snout, passes back through the nostril to eye; beginning behind eye it involves tympanum and runs back low on the sides, breaking up into irregular spots as it rises diagonally on the posterior part of the side; limbs barred with brownish, two bars each on thigh and tibia, several on foot; the tibial spots are continued onto front face of tibia; upper lip, and to a lesser extent lower lip, bordered with a narrow band of brown, narrowly edged with cream or white; ventral surface dirty-white, immaculate; a well-defined

Measurements (in mm.) of *Hyla wrightorum* sp. nov.

Number	USNM 9338a	MZUM † 19141 Type	USNM 9338b	USNM 26607	USNM 26605
Sex	♀	♀	♀	♀	♂
Snout to vent	42	42	40	37	34.2
Head length to jaw angle	12.4	13	12*	13.2	12.2
Head width, greatest	13.1	13.2	12	12	11
Diameter of eye	4.5	4.35	4.3	4	3.5
Diameter of tympanum	2.6	2.85	2.3	2.5	2.1
Length of snout	5.2	5.2	5	5.4	5
Interorbital width	4	4	3.6	4	3.85
Eyelid	3.5	3.8	3.2	3.5	2.9
Foreleg	21.2	23.2	22.6	21	18
Hind leg	68	70.5	62	60	55
Tibia	22	23	20	20	18
Foot and tarsus	30	31.5	27.5	26.2	23

* Head somewhat dried and distorted.

† Museum of Zoölogy, University of Michigan

spot on anterior side of upper arm, and none or only a vague scattering of pigment on the chin and throat; underside of feet and hands with some pigment and lighter flecks; posterior and anterior part of femur and groin region with an equal distribution of fine, brown pigment.

Remarks. Specimens of this species have been present in the United States National Museum since 1874. Yarrow (North American Reptilia and Batrachia, Bull. U. S. Nat. Mus. No. 24, 1882, p. 172) lists No. 8508, 2 spec. Nutrias, New Mexico, and No. 9338, 2 spec. Santa Fe, New Mexico, June, 1874, H. W. Henshaw, collector, under the designation *Hyla eximia* Baird. In Cope's Batrachia of North America, Bull. U. S. Nat. Mus., No. 34, these specimens are not listed under *Hyla eximia*, nor, so far as I can discover, is there reference made to them.

In the Stejneger and Barbour, Check List of North American Amphibia and Reptiles, 3d Ed., 1933, pp. 34-35, *Hyla eximia* is listed from Mexico, Texas, New Mexico and Arizona. *Hyla gracilipes* is likewise listed, p. 35. I have seen no specimens of the *eximia* group from Texas, but if a form of the group occurs there, it may belong to this species (*wrightorum*). I have examined a series of specimens of this species in the collection at Cornell University, due to the kindness of Dr. A. H. Wright. These specimens were collected near McNary, in Arizona, by W. C. Chapel, Jr. Mr. F. Willis King (*loc. cit.*) has published a short note on the species based on specimens collected by him at Mormon Lake, Arizona.

This species is related more closely to *H. regilla* and *H. lafrentzi* than to the typical *H. eximia*. From the former it differs in having a smooth rather than pustular skin, and in having a longer leg, the tibiotarsal joint reaching the tip of the snout or beyond, instead of to the region of the eye. The webbing of the toes is somewhat less and the diameter of the tympanum is greater than half the diameter of the eye; the toes and fingers are wider with somewhat wider pads.

From *H. lafrentzi* it differs in having the webbing between the toes somewhat less with narrower fingers and toes, larger choanae, a shorter, blunter snout, somewhat deeper in front of nostrils. The front edge of the tibia is heavily spotted with brown, instead of having it blackish with a cream-white or silver line which is continued to foot.

It is a species apparently adapted to semidesert conditions.

The species is dedicated to Anna Allen Wright and Albert Hazen Wright in recognition of their work in American herpetology.

PLATE XLVI

Hyla eximia Baird

FIG. 1. *Hyla eximia* Baird. EHT-HMS, No. 2021, ♀; Tepic, Nayarit, Mexico. × 1.

FIG. 2. Same. EHT-HMS, No. 2023, ♀; Tepic, Nayarit, Mexico. × 1.

FIG. 3. Same. EHT-HMS, No. 1931, ♂; Aguascalientes, Aguascalientes, Mexico. × 1.

FIG. 4. Same. EHT-HMS, No. 2018, ♂; Tepic, Nayarit, Mexico. × 1.

FIG. 5. Same. EHT-HMS, No. 2015, ♂; Tepic, Nayarit, Mexico. × 1.

FIG. 6. Same. EHT-HMS, No. 1925, ♂; Aguascalientes, Aguascalientes, Mexico. × 1.

FIG. 7. Same. EHT-HMS, No. 1924, ♂; Aguascalientes, Aguascalientes, Mexico. × 1.

FIG. 8. Same. EHT-HMS, No. 1947, ♂; Aguascalientes, Aguascalientes, Mexico. × 1.

FIG. 9. Same. EHT-HMS, No. 2061, ♂; near Uruapan, Michoacán. × 1.

FIG. 10. Same. EHT-HMS, No. 2064, ♂; near Uruapan, Michoacán. × 1.

PLATE XLVI

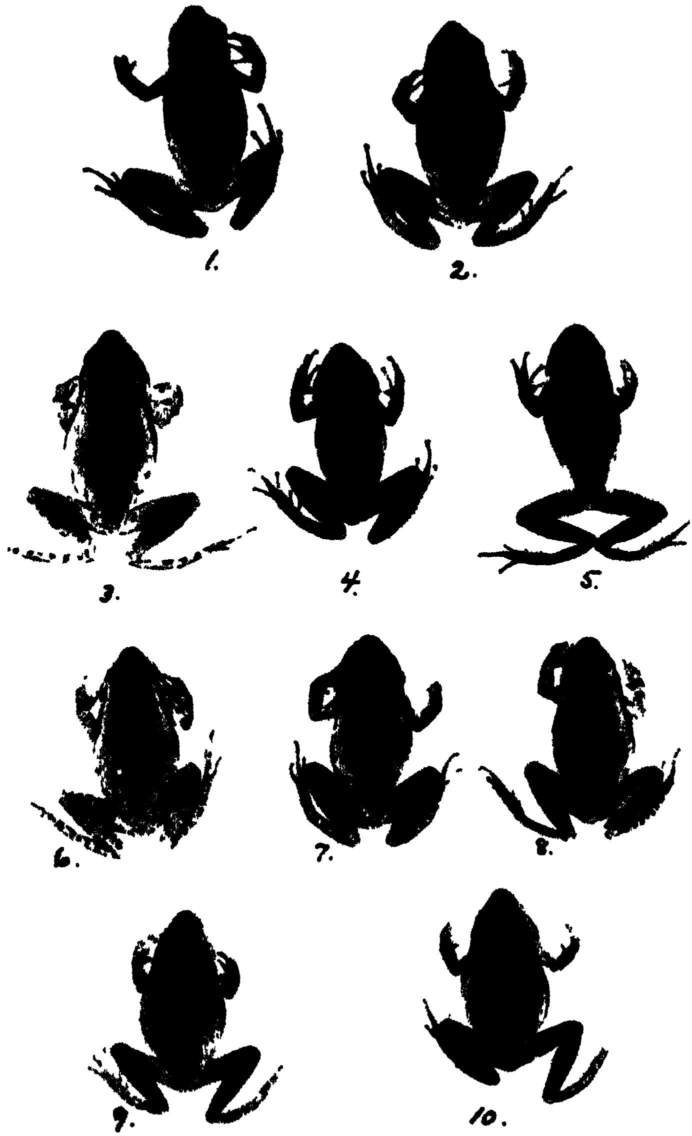


PLATE XLVII

MEXICAN HYLIDAE

FIG. 1. *Hyla wrightorum* sp. nov. Holotype, MZUM, No. 79141, 11 miles south, Springerville, Apache county, Arizona, U. S. A.; actual length, 42 mm.

FIG. 2. *Hyla cárdenasi* sp. nov. Holotype, USNM, No. 84403, Puebla, Puebla, Mexico; actual length, 39 mm. (Spotting on back and limbs due to injuries.)

FIG. 3. *Hyla gracilipes*, Cope. Cotype, USNM, No. 15318 ♀; actual length, 22 mm.

FIG. 4. Same. Cotype, USNM, No. 15319 ♀; actual length, 23 mm.

FIG. 5. Same. Cotype, USNM, No. 15320 ♀; actual length, 21.8 mm.

PLATE XLVII

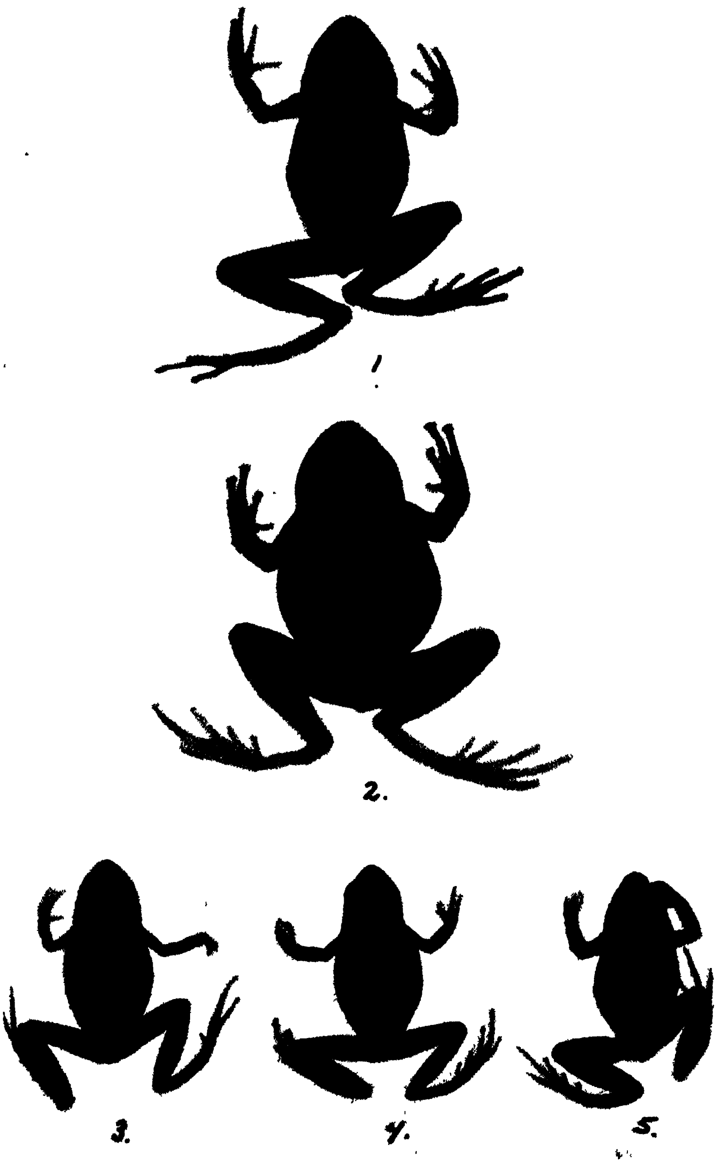


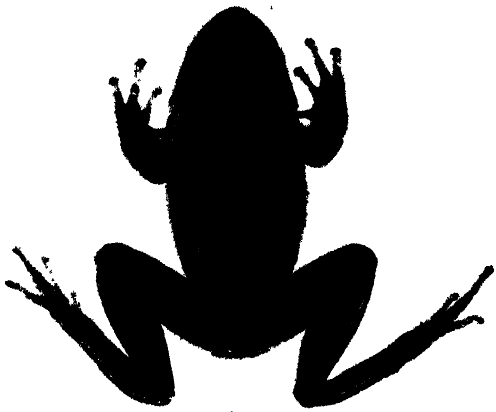
PLATE XLVIII

Hyla lafrentzi Mertens and Wolterstorff

FIG. 1. EHT-HMS, No. 5978, ♂; Lake Zempoala, Morelos, Mexico; actual length, 43.2 mm.

FIG. 2. EHT-HMS, No. 5980, ♀; Lake Zempoala, Morelos, Mexico; actual length, 50 mm.

PLATE XLVIII



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THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

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A Contribution to the Taxonomy of the Subfamily Issinae in America North of Mexico (Fulgoridae, Homoptera)

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PART II

ABSTRACT: This paper comprises the second part of a monograph dealing with the taxonomy of the subfamily Issinae (Fulgoridae, Homoptera) in America, north of Mexico. In Part I * only the genus *Dictyssa* was discussed. In this part a complete key to the genera, which number twenty-one in all, is given and the following twelve genera have been studied in detail: *Euthiscia*, *Hysteropterum*, *Dictyonia*, *Dictyssonia*, *Dictyonissus*, *Neaethus*, *Misodema*, *Ulixes*, *Tylana*, *Traxus*, *Thionia* and *Picumma*. Of these twelve genera the following contain only one species, being either monotypic or at least having only one species that occurs north of Mexico: *Euthiscia*, *Dictyonia*, *Dictyssonia*, *Misodema*, *Ulixes*, *Tylana*, and *Traxus*. In the discussions of the remaining five genera a key to the species in each genus is given. The genus *Thionia* contains seven species, *Picumma* two species, *Hysteropterum* seven species and one variety, *Dictyonissus* two species, and *Neaethus* thirteen. The total number of species studied is fifty-three. The following species are described as new: *Thionia omani*, *Picumma chinai*, *Hysteropterum fuscomaculosum*, *Dictyonissus nigrophilosus*, *Neaethus perlucidus*, *Neaethus sinchamatus*, *Neaethus similis*, *Neaethus jacintiensus*, *Neaethus curvaminis*, *Neaethus uniformus*, and *Neaethus diversus*. *Issomorphus maculatus* Melichar has been placed in the genus *Picumma*.

Some of the older species have been redescribed and comparative notes and drawings are given for all species except *Hysteropterum morum* Van Duz. The male genitalia are described and figured for all species except the following: *Ulixes scutatus* (not yet recorded from the United States), *Thionia omani* and *Thionia quinquata*.

The characters of most value for classification are the male genitalia, the shape and position on the body of the tegmina, the size of the hind wings, and the wing venation, including the fineness or abundance of reticulation.

* The University of Kansas Science Bulletin, Vol. XXIV, No. 17, 1936.

KEY TO THE GENERA

1. Tegmina entirely covering abdomen or greater portion of it, parchmentlike or vitreous, or a combination of both 2

   Tegmina short and usually extending only partially over abdomen, except in macropterous forms of some species which are always more or less hyaline, parchmentlike, thick or opaque ....(Tribe Caliscelini) 16

2. (1) Hind wings either absent, rudimentary or else very narrowed with vein Sc_1 present and vein Cu_1 branched or hind wings long, notched at apex, vein Sc_1 not present and vein Cu_1 not branched; posterior tibiae with 2 to 5 spines or, entirely unarmed 3

   Hind wings present, narrow, not notched at apex, anal area small or else rudimentary; posterior tibiae with 2 to 4 lateral spines; vein Sc_1 absent (Tribe Issini) 4

3. (2) Hind wings present, entire, with strongly marked notches at the joints of the folds, anal area large; vein Sc_1 absent; usually large insects varying from 5.5 to 8.1 mm.................................(Tribe Thionini) 6

   Hind wings usually absent or rudimentary (a few species of Neaethus excepted); vein Sc_1 present (*Dictyssonia* excepted); small insects, usually under 5.5 mm.............................(Tribe Hysteropterini) 7

4. (2) Frons deeply concave or perpendicular; clypeus strongly deflexed and horizontal ....*Traxus* Metcalf, p. 449

   Frons not concave; clypeus not so deeply inflexed or horizontal 5

5. (4) Tegmina rugulose with veins slightly elevated, finely reticulated; hind wings small and narrow ....*Ulixes* Stal, p. 451

   Tegmina not rugulose, with strongly elevated veins, larger reticulations; hind wings half the length of tegmina, not visible when latter is in repose. *Tylana* Stal, p. 454

6. (3) Cubital vein of tegmen simple and costal region vertical to the body; posterior tibiae with 2 spines........... ....*Thionia* Stal, p. 456

   Cubital vein of tegmen branched; posterior tibiae with usually 4 spines. *Picumna* Stal, p. 471

7. (3) Tegmina more or less opaque or with vitreous spots and oblique bands...... 8

   Tegmina vitreous entirely except *Misodema* and some species of *Neaethus* parchmentlike 12

8. (7) Vertex not conically produced; posterior tibiae with one or more spines..... 9

   Vertex conically produced; posterior tibiae without spines; tegmina not extending beyond tip of clavus....................*Euthiscia* Van Duzee, p. 479

9. (8) Tegmina with vitreous patches or spots (*Dictyssa fusca* excepted) not necessarily narrowed at apices; posterior tibiae with 2 to 4 spines............ 10

   Tegmina uniformly opaque with no vitreous spots or bands, narrowed and rounded at apices; more or less thickly branched veins; posterior tibiae with 1 or 2 spines.................*Hysteropterum* Amyot and Serville, p. 481

10. (9) Tegmina either as broad as long or approximately semicircular in shape, partly opaque, usually with an oblique hyaline band across clavus and corium or some sort of hyaline markings; costal margin decidedly rounding 11

   Tegmina oblong, costal margin nearly straight or if rounding with a distinct bulla present at base of each wing................................ 14

11. (10) Tegmina semicircular in shape, not closely adpressed to body, veins of corium forming irregular cells, some of which usually (not always) are vitreous or light colored.........................*Dictyssa* Melichar *

   Tegmina practically as broad as long, held almost vertically, cells of corium exceptionally few and large and distinctly angular......*Dictyonia* Uhler, p. 496

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* Key to species and descriptions of this genus in Part I of this paper in Univ. of Kan. Sci. Bull., Vol. XXIV, p. 424, 1936.

12. (7) Upper surface hispid; vertex obtusely produced; posterior tibiae with 3 spines; tegmina with a fine network of coarse veins and main veins not evident .... *Dictyonissus* Uhler, p. 498

Upper surface not hispid; vertex not produced or, if so, triangularly produced; posterior tibiae with 2 or 4 spines 13

13. (12) Tegmina placed more or less vertically, close to body; posterior tibiae with 2 spines; head and eyes as broad as or broader than pronotum *Neaethus* Stal, p. 501

Tegmina opaque, strongly inflated, gradually narrowed behind and with very short clavus; head narrower than pronotum; posterior tibiae with four strong spines .... *Musodema* Melichar, p. 534

14. (10) Tegmina broad, costal margin rounding 15

Tegmina decidedly oblong, approximately same length throughout, with costal margin nearly straight .... *Dictydea* Uhler

15. (14) Tegmina with distinct bullae at outer angles of the corium; reticulation finer .... *Dictyssonia* Ball, p. 536

Tegmina broadest just at middle; reticulation coarser .... *Dictyobia* Uhler *

16. (1) Body robust; narrow, lance-shaped tegmina, extending spearlike to or beyond apex of abdomen .... *Danepteryx* Uhler *

Body more elongate, tegmina not strap-shaped, usually covering only one half of abdomen 17

17. (16) Head produced snout-like 18

Head not produced snout-like 19

18. (17) Fore and middle tibiae expanded .... *Fitchiella* (Fitch) *

Fore and middle tibiae not expanded .... *Bruchomorpha* Newman

19. (17) Tegmina oval and abbreviated; margin of vertex and front produced into acute hornlike angles above eyes .... *Osbornia* Ball *

Tegmina more parallel, longer; no such acute angles above eyes 20

20. (19) Head large, including eyes, a little wider than base of closed tegmina; front rounded, prominent; vertex short .... *Aphelonema* Stal *

Head, including eyes, narrower than pronotum or base of closed tegmina; front triangular; vertex long and narrow .... *Papagona* Ball *

* Last seven genera will appear in part 3.

THE GENUS TRAXUS Metcalf, 1923

Metcalf, Z. P. The Fulgoridae of Eastern North America. Jr. of Elisha Mitchell Society XXXVIII, 1923.

Comparative notes. This genus is separated from all other North American genera by the deeply concave frons which is perpendicular and the strongly inflexed horizontal clypeus, the basal margin of which scarcely protrudes into the frons, except right at middle for a short distance, where it appears rather bulbous as viewed from the side. Other distinguishing characters are: the triangularly incised vertex; rugulose appearance; tegmina thick with a roughened texture, transversed by elevated longitudinal veins and a network of less distinct veins at apex, costal margin not inflexed; clavus very short, its apex only reaching halfway of the length of the tegmen; hind wings small or rudimentary; number of spines on hind tibiae two.

The wing venation seems to follow that of the genus *Picumna*. The general features are: vein Sc_1 is lacking; veins Sc_2 and R

united at base for a short distance only; apparently both veins M and Cu_1 are two-branched, although this is not always discernible, since all the longitudinal veins, posterior to the median depression, are lost in the uniform apical reticulation; vein Cu_2 follows the claval suture; veins 1st A and 2d A united at apex to form the characteristic Y-vein, although each are quite sinuate, pulled out of a straight course by the concavity of the tegmen.

Traxus fulvus Metcalf

(Plates XLIX-LII-LIII-LV-LVI)

Metcalf, Z. P. The Fulgoridae of Eastern North America. Jr. of Elisha Mitchell Society XXXVIII, 1923.

Comparative notes. General color, grayish-tan with dark-brown flecks and spots. The species is easily recognized structurally by the subglobose, convex elytra with several prominent elevations located as follows: the acute angle formed by the lateral margins of the vertex and the frons where they meet above the eyes; on each lateral half of pronotum a carinalike ridge following the eye to the ventral side; on the mesonotum each lateral carina elevated on a prominent boss; and a transverse hump, beginning on the anterior half of the clavus and continuing across the corium to the costal margin, back of which is a transverse concavity extending across entire tegmen.

This species had been brought to the author's attention recently by one or two colleagues, who were of the opinion that it was synonymous with *Ulixes scutatus* Walker, a Mexican species, figured and discussed by Fowler in the Biologia Centrali Americana. The writer sent a specimen to Mr. W. E. China of the British Museum for comparison with the type. In a letter to the writer, Mr. China states: "This is nothing like Walker's species and does not belong to the genus *Ulixes*. Indeed, it belongs to quite a different subfamily, the Hysteropterinae. It appears likely to be a new genus. The structure of the frons and clypeus is very unusual."

Male genitalia. Resembling the genitalia of *Picumna* in general outline. The tenth abdominal segment (anal flap) seems distinctive because of its ovate outline. It is a flattened tube, narrowed considerably at base, then rounding out through middle and from thereon with its ventral margin extending caudad as a flat, roundingly pointed flap. The eleventh segment scarcely shows beyond the dorsal margin of the tubular part of the tenth segment. It bears a much shorter and thicker ventral stylus than is found in other genera.

Harpagones (genital styli of authors) visible externally as two broad triangular plates which are about twice as long as width at base. Each harpago as viewed from a lateral, flattened view is a subquadrangular plate with its dorsal margin at about middle projected dorsad as an irregular flat extension terminating in a slender, cephalad, curving hook and also bearing on its cephalic margin a flat, recurved hook which bends caudad.

The aedeagus and theca are difficult to distinguish in this genus as in *Picumna* or *Tylana*. Together they appear as a bilaterally symmetrical, broad, tubular structure. From a lateral view the theca shows its apical margin, broadly notched through middle, due to its ventral region being greatly extended caudad as a slightly pointed lobe which bears on each side a rounded lip-like extension lying *in situ* just posterior to each aedeagal hook, and its dorsal region extended caudad into a bulbous knob. The apex of the aedeagus apparently does not show beyond the theca. However, two pairs of aedeagal hooks are conspicuous. One hook emerges from the thecal notch, extends ventrad a short distance, then abruptly bends cephalad and extends forward almost to the base of the aedeagus. The second hook on each side also emerges at the notch of the theca and is directed cephalad to a little beyond middle of aedeagus. This hook is heavily sclerotized and is forked at its middle into two sharply pointed, curved hooks, the dorsal one of which is slightly longer than the ventral one.

Notes on distribution. Metcalf lists the type specimens as all coming from Brownsville, Texas.

In the National Museum collection there is a pair which were taken at Brownsville, Texas, in June by Paul Oman. In the Snow Entomological collection at the University of Kansas is another pair taken by R. H. Beamer at Cameron county, Texas, in August. Apparently this is one of the rare species in this subfamily.

Location of types. Probably in the collection of Z. P. Metcalf, Raleigh, S. C.

THE GENUS ULIXES Stal, 1858

(Plates XLIX, LII, LIV)

Stal, Carolus. Bidrag till Rio Janeiro—Traktens, Hem.-Fauna, II, p. 67, 1858.

Fowler, W. W. Fulgoridae. Biologia Centrali Americana. Homoptera I, pp. 113-119, 1904.

Walker, F. Insecta Saundersiana, Homop. p. 44, 1858 (Issus).

Comparative notes. Fowler characterizes this genus as follows: Wings small or rudimentary, not notched at apex; frons perpendicular, clypeus more or less inflexed; peculiar rough facies; strongly

raised venation; general shape convex or subglobular and tegmina as a rule strongly convex (*scutatus* excepted); spines on hind tibia two to four as given by Fowler in the Biologia Centrali Americana. There are four in *scutatus*. Fowler in his original description for *intermedius* states that there are four. The writer believes that four is the correct number for the genus.

One of the most distinctive characters which the present author notes is the short clavus, whose apex extends only slightly over one half the length of the tegmen. Another is that the costal border is not inflexed as in many other genera.

The general features of the wing venation as is found in *Ulixes scutatus* are: a separate Sc_1 vein lacking; veins Sc_2 and R united for a short distance at base, curving outwardly at this point so that these veins as they extend parallel with each other to the apex, are much nearer to the costal border than in most species; vein M forking into two branches about midway of the tegmen; vein Cu_1 apparently single-branched, its tip lost in the apical reticulation; vein Cu_2 following the anal suture; veins 1st A and 2d A united at tip to form the characteristic Y-vein.

KEY TO SPECIES

Ia. Head shorter; tegmina more rounding at tip; frons perpendicular; clypeus strongly inflexed .... *Ulixes scutatus* Walker.

Ib. Head longer; tegmina obtuse at apex; frons and clypeus gradually rounded under head .... *Ulixes intermedius* Fowler.

Note. Only *scutatus* has been collected in this country to date. *Ulixes intermedius,* however, was collected by Dr. E. D. Ball in the Sierra Madre mountains, Mexico. His material was in the type series of Fowler's and was sent back to him by Fowler. Doctor Ball very kindly pointed out the differences of *intermedius,* which he has in his collection, with a solitary specimen of *scutatus,* which the writer sent to him for comparison. The differences which Doctor Ball noted are incorporated in the above key, which the present writer considered might be useful, insomuch as Doctor Ball has mentioned that any Mexican material collected by him in these mountains is almost certain at some time to turn up in the southwest of our country.

The single female specimen of *scutatus* Walker, mentioned above, has been compared by the writer with a single male specimen sent to the writer for study from the British Museum collection. The latter specimen was compared by Mr. China with the type. The female specimen from the United States was identical to the male specimen in body form and coloring in every particular with the

following exceptions: the United States female specimen had the clypeus more distinctly retreating than did the other one (see drawing), and the female specimen, contrary to the general rule, was smaller by one millimeter than the male. Since the male was collected at Oajaca, Mexico, and the female at Yarnell, Ariz., this difference might be accounted for by difference in range and the structural difference by that of difference in sex.

Ulixes scutatus Walker

(Plates XLIX, LII, LIV)

Comparative notes. A large, broad species, the same or larger than *Tylana ustulata*, measuring 7 to 8 mm. long and 5 to 6 mm. wide across greatest width of tegmina. Greyish or greyish-brown in color. Vertex and thorax uniformly brown, flecked with yellow spots. Tegmina yellowish-tan, rather solidly flecked with brown. Underside of abdomen yellow, sparsely marked with irregular brown spots.

This species is readily distinguished from any other North American form by its broad, flaring tegmina, its short clavus, its inflexed clypeus and the lateral carinae on pronotum being much nearer to the posterior border of the sclerite than to the eye. In the inflexed clypeus and also in the short clavus it perhaps more nearly resembles *Traxus fulvus* than any other species. It is easily separated from this species, however, by lacking the mesonotal bosses, by having four spines on the hind tibiae instead of two and by the general shapes of the bodies.

Male genitalia. No specimen was available to the writer for dissection. Only one specimen was obtainable for study. This was a specimen from the British Museum, compared with the type by Mr. China and loaned to the writer for temporary use. A drawing of the external genitalia of this specimen is figured. Fortunately the harpagones are spread apart so that the aedeagal structure can be partially seen.

From this position it can be seen that the theca on the ventral side extends to almost the apex of the aedeagus and on the dorsal side extends slightly beyond, ending in a rather swollen knob. Arising from each lateral slit of the theca are two well-sclerotized aedeagal hooks, the more dorsal one extending laterad on the outside of the harpago and bending back cephalad so that its apex extends under the rim of the last complete abdominal segment, the ventral hook a long, bladelike structure, bearing a short lateral hook near

base and tapering to a finely pointed apex, which does not quite reach the rim of the abdominal segment.

Notes on distribution. Fowler lists this species from Mexico and from San Geronimo, Guatemala. In the National Museum at Washington is one specimen collected by Mr. Paul Oman from Yarnell Heights, Ariz., in 1933. This one female specimen was compared with a male specimen from the British Museum collected at Oajaca, Mexico, which Mr. China compared with the Walker type and loaned to the writer for study.

Location of type. British Museum, England.

THE GENUS TYLANA Stal, 1862

Stal, Carolus. Rio Jan. Hemip. II, p. 67, 1862.

Comparative notes. Some of the outstanding characteristics of the genus are: head, including eyes, somewhat smaller than thorax, frons with three longitudinal carinae, not united at base, clypeus inflated; pronotum with a raised anterior margin which extends ventrad as a distinct carina which finally joins the posterior margin; scutellum tricarinate; tegmina obliquely truncate at apex, with a very long clavus which extends approximately three fourths the length of the tegmen, longitudinal veins very prominent and rugulose, cross veins prominent at apex of tegmen, making a prominent network; hind wings short, extending only halfway, not notched at apical edge, the anal lobes not very broad; femora of hind legs with two spines.

Tylana ustulata Uhler, 1876

(Plates XLIX, LII, LIII, LIV, LVI)

Uhler, P. R. List of the Hemiptera of the Region West of the Mississippi River, Including Those Collected During the Hayden Explorations of 1873. Bul. U. S. Geol. Geog. Surv. I, p. 354, 1876.

Comparative notes. There is only one species in the genus in North America, north of Mexico. Therefore, the characteristics pointed out as distinctive for the genus also are specially valuable in separating this species from other members of the subfamily. General color pitch-brown to pitch-black, with lighter markings, the latter in most specimens making a light saddle across middle of tegmina. *Tylana ustulata* is one of the largest species in the entire subfamily, measuring 6 to 7 mm. in length from tip of head to apex of tegmen. Superficially it closely resembles, in color and size, *Picumna maculata* Melichar and *Picumna chinai* n. sp. From these

it can be distinguished by having the tegulae of the wings hidden under the pronotum and the base of the wing somewhat twisted so that the longitudinal veins appear to start immediately behind the pronotal margin; by having prominent cross veins at apex of clavus making a network; by having the lateral margins of the vertex elevated and meeting the lateral carinae of the frons in an acutely produced angle above the eyes; and by having the costal margin broadly expanded and bent under for half the length of the tegmen, at which point the costal margin is distinctly angulate, and by having short hind wings, not over half the length of the tegmina.

Wing venation. Due to the bent-under costal margin of the tegmen the subcostal vein does not show from a dorsal view of the insect, and although this costal area is rather broadly expanded no Sc_1 vein apparently is present. Another peculiarity is that the basal cell from which the longitudinal veins arise in other genera seems to be obliterated or pushed so far forward that the veins appear to start just back of the pronotal margin, and lastly an ambient vein is present, starting at apex of clavus and continuing around the apical margin to the costal margin, where it ends at the angle halfway down the length of the tegmen. All the veins run rather parallel. Sc_2 and R are united for only a very short distance, then each extends as a single vein to the apical region, where they are lost in the reticulation; M divides into two branches, each of which is also lost in the apical reticulation; Cu_1 is single branched; Cu_2 runs along the claval suture; 1st A and 2d A unite to form a prominent Y-vein in the clavus.

Male genitalia. The tenth abdominal segment forms the so-called anal segment or flap, whose apex lies closely against the harpagones. Basally it is a broad tube which has its ventral margin extended caudad as a broad flap. The lateral margin of the flap constricts at middle, then rounds out slightly and finally tapers to the truncate apex, which is slightly emarginate through middle. The eleventh segment shows beyond the dorsal margin of the tubular part of the tenth segment as a short ringlike segment, bearing a broad, pointed stylus.

Externally, the harpagones (genital styli of authors) appear on the ventral side of the body as two adjoining triangular plates, whose combined width at base is about equal to their length. Each harpago as viewed from a flattened lateral position (see drawing No. 4, plate LVI) is roughly quadrangular with its dorsocephalic angle obliquely cut off and its dorsocaudal angle greatly prolonged dorsad

into a broad, sharply pointed projection, at base of which is a short, broad, flaplike hook.

The aedeagus is bilaterally symmetrical, almost completely hidden by the theca. With the theca the aedeagus from a ventral view appears to be a broad, capsulelike tube bearing two long tapering sclerotized processes, whose apices extend beyond the base of the genital tube. These processes are aedeagal hooks which extend out from a notch in the theca at a point about one third of the way from the apex of the aedeagus, then broadly curve ventrad a short distance, after which they extend directly cephalad, to a point beyond base of the latter. The theca on the ventral side is truncate posteriorly. On the dorsal side it is somewhat more membranous, appears sunken lengthwise through the middle and has a spatulate, lobelike extension just posterior to the base of the aedeagal hook and is also expanded lobelike at apex.

Location of type material. United States National Museum, Washington, D. C.

Notes on distribution. Uhler in his original description states that this species inhabits Colorado and Arizona. Specimens are at hand for study from the following places in Arizona: Sabino canyon, Vail, Baboquivari mountains, Pima county, Miami and Tucson. Specimens from Miami, Ariz., were taken by Dr. R. H. Beamer on a tree-like form of Equisetum. One specimen was taken by R. H. Beamer from Rodeo, N. M., in August, 1935.

THE GENUS THIONIA Stal, 1859

Stal, Carolus. Novae quaedam Fulgorinem formae species que insigniores. Berl. Ent. Zeit. III, p. 313, 1859.

Fowler, W. W. Fulgoridae. Biologia Centrali Americana, Homoptera I, pp. 113-119, 1904.

Melichar, Leopold. Monograph der Issiden (Homoptera) abh. K.K. Zool.—Bot. Ges. Wien III, 1906.

Metcalf, Z. P. The Fulgoridae of Eastern North America. Jn. of the Elisha Mitchell Society XXXVIII, 1923.

Comparative notes. The genus includes species of large or medium size, varying from 5.5 mm. to 8.1 mm. The vertex is chevronlike in shape, depressed through middle and with sharply elevated margins. The frons is elongate with elevated margins and three carinae usually present (*simplex* excepted), the two lateral ones of which have their posterior ends curving to meet the median one. The costal area of the tegmen is not deflexed as in *Tylana*, nor horizontal as in *Picumna* and *Ulixes*, but is in a vertical position, while the rest of the tegmen is more or less slopingly horizontal to the body.

The tegulae are inconspicuous, showing only at the extreme sides. The longitudinal veins are prominent; cross veins are lacking for the most part, but sometimes show as a faint network at apex of the tegmen. Hind wings present and as long as the tegmina. Posterior tibiae with only two spines.

Vein Sc in this genus is not branched, and, therefore, no costal vein (Sc_1) is present. Vein Sc_2 and R arise from a main vein trunk near the base of the wing as a single vein, but very shortly separate into two separate veins which run parallel to apex of the tegmen. Vein M divides near middle of the wing into two branches and branch M_{1+2} may or may not divide at apex. Cu_1 is simple, Cu_2 follows the anal suture. Veins 1st A and 2d A are united near the apex of clavus to form the characteristic Y-vein.

The general color for the genus varies from tan to brown, sometimes unicolorous, but usually variegated with darker patches or with small, dark-brown, round speckles or with both.

This genus resembles the genus *Picumna* Stal very closely, but is easily distinguished by the bispinose hind tibia and vein Cu_1 being simple, while in the other genus the tibia is quadrispinose and vein Cu_1 branched.

HISTORY OF THE GENUS

Stal described the genus in 1859 in Novae Quaedam Fulgorinem Formae Speciesque Insigniores, Berl. Ent. Zeit. III. Van Duzee gives the logotype of the genus as *longipennis* (Spin.). In 1830 two species, namely *simplex* and *elliptica*, were described by Germar, who placed them in the genus *Issus*. In the same year Say described *bullata* as a *Flata*. In 1905 Fowler described a species in Mexico which he called *naso*. Recently a long series of this species has been taken in our southwestern states. In 1908 Van Duzee added the long-headed *producta* to the group and in 1923 Metcalf added *quinquata*. In this paper one new species is being added, *T. omani*.

This makes a total of seven species, which represent in collections the North American species of *Thionia*.

To this list may be added the two species of Melichar's (1906) *transversalis* and *ocellata*, which the writer believes are not found in this country, since the type locality was given merely as N. A. No specimens are present in the National Museum collection and no specimens have turned up in the numerous collections thus far studied.

KEY TO SPECIES

1. Vertex considerably broader than long 2
   Vertex longer than broad 4

2. (1) Anterior margin of vertex rounding, not produced anteriorly beyond eyes; tegmina narrow, not bullate, unicolorous .... *simplex* (Germar), p. 458
   Anterior margin of vertex slightly angulate; tegmina bullate and broad at base 3

3. (2) Vertex concave, lateral margins greatly elevated; tegmina not narrowed considerably beyond middle .... *elliptica* (Germar), p. 459
   Vertex not concave, lateral margins not elevated; tegmina greatly narrowed and reflexed at apex .... *omani* n. sp., p. 461

4. (1) Head triangularly produced a considerable distance beyond eyes 5
   Head produced only very slightly beyond eyes or not at all 6

5. (4) Head produced beyond eyes a distance more than or equal to the length of the eye; a larger species, measuring 6.8 mm. to 8.4 mm. ....*naso* Fowler, p. 463
   Head produced beyond eyes a distance less than the length of the eye; a smaller species, measuring 5.5 mm. to 6.8 mm. ......*producta* Van Duzee, p. 465

6. (4) All six margins of the chevronlike vertex equal in length so that its lateroanterior angle is posterior to the anterior margin of the eye; larger insects, measuring 8 mm. for females .... *quinquata* Metcalf, p. 467
   Lateral margin of vertex longer than the four posterior and anterior margins, thus bringing the lateroanterior angle even with or anterior to the anterior margin of the eye. Size, 6.4 mm. to 7.6 mm. .... *bullata* Say, p. 468

Thionia simplex (Germar), 1830

(Plates L, LI, LII, LIII, LV, LVI)

Germar. Thon's Ent. Arch., II, p. 51. Issus.
Dozier, Herbert L. The Fulgoridae or Plant-Hoppers of Mississippi, Including Those of Possible Occurrence. Miss. Agri. Exp. Sta. A. & M. College, p. 105, 1928.

Comparative notes. This is the smallest species in the genus, measuring 6 mm. to 6.5 mm. in length. It is distinguished easily by color, being uniformly brownish-yellow without markings. Structurally it is readily distinguished by the squarish vertex which is broader than long; by the frons which is only slightly longer than wide, narrowed between the eyes and bearing only one median carina or sometimes with two lateral carinae just faintly indicated on either side.

Male genitalia. The tenth abdominal segment forms the so-called anal tube or flap. Basally it is a broad, flat tube that has its ventral margin greatly extended caudad into an elongate spatulate lobe or flap which is truncate at apex. The eleventh segment shows beyond the dorsal margin of the tubular part of the tenth segment as a short, ringlike segment bearing a very short, slender stylus.

Externally the harpagones (genital styli of authors) appear on the ventral side of the body as two broad triangular plates which closely adjoin along their mesal margins. As viewed from a flattened, lateral view each harpago is a broad, pear-shaped plate, narrowed at base, greatly broadened across apex, where the dorsal,

apical angle is extended dorsad in a slightly pointed, recurved process, at the base of which is a broad, flat posteriorly projecting flap. (See drawing 5, plate LVI.)

The aedeagal structure is similar to that of the genus *Picumna*, being a bilaterally symmetrical, broad, tubular organ in which the limits of the theca and aedeagus are hard to distinguish, since the theca is sclerotized considerably and almost completely covers the aedeagus. From a lateral view the theca can be seen to extend almost to apex of aedeagus. Its posterior margin is truncate on the ventral side, but has its dorsal angle extended caudad as two processes, the dorsal one of the two being an elongate, slightly recurved lobe, the ventral one a sharply pointed hook which bends somewhat ventrad. The apex of the aedeagus shows as a thick lobe between the processes of the theca and bears two long, narrow, pointed processes, which protrude, one on each side, from the lateral notches in the theca and bend directly cephalad, extending as far forward as the base of the aedeagus.

Location of type. Possibly in the Museum at Budapest.

Notes on distribution. This is a southern and eastern species. The type locality is given as Kentucky.

A large series of this species was available for study from the following localities: Alabama, Arkansas, Florida, Mississippi, North Carolina, South Carolina, and Virginia.

Dozier (1928) adds the following states in which it has been collected: New Jersey, Maryland, Washington, D. C., Ohio, Kentucky, Missouri, Texas and Tennessee.

Thionia elliptica (Germar), 1830

(Plates L, LI, LII, LIII, LV, LVI)

Germar. Thons. Ent. Arch. II, p. 51 (*Issus*).

Dozier, Herbert L. The Fulgoridae or Plant-Hoppers of Mississippi, Including Those of Possible Occurrence. Miss. Agric. Exp. Sta. A. & M. College, p. 105, 1928.

Comparative notes. This species measures 7 mm. to 7.5 mm. from apex of head to the tips of the tegmina. It is distinguished from other species in the genus by the greater proportional width of the tegmina, the deeply concave basal margin of the frons, by having only one longitudinal carina on the frons which extends down the median line and is sharply elevated and by the very deeply concave vertex with its greatly elevated anterior corners.

The general color is a yellowish or greenish-tan, speckled with brown. In addition, the clavus of each tegmen through its middle third bears a triangle of dark brown and has a dark apex.

Male genitalia. The tenth abdominal segment or anal flap is much broader than that of *simplex*, being about twice as wide as long. At base it is a broad, flat tube that has its ventral margin greatly extended caudad into an elongate spatulate lobe which is slightly emarginate at apex. The eleventh segment shows beyond the dorsal margin of the tubular part of the tenth segment as a short, ringlike segment, bearing a short, blunt stylus.

Externally the harpagones (genital styli of authors) appear on the ventral side of the body as two broad, triangular plates which closely adjoin along their mesal margins. As viewed from a flattened, lateral view each harpago is a broad, pear-shaped plate, narrowed at base, over again as wide across apex and with its dorso-apical angle extended dorsad into a long process, bearing a posteriorly bent external flap at its base. (See drawing 7, plate LVI.)

The aedeagal structure is a bilaterally symmetrical, broad, tubular organ with the aedeagus and theca about equally sclerotized and therefore difficult to distinguish. The theca covers the aedeagus as a cylinder for about half its length, then splits on each side into a dorsal flap which extends caudad, completely covering the aedeagus to the tip, and on its ventral side forms a rounded caudal projecting lobe just posterior to the aedeagal hook. On the ventral side the theca extends almost to the tip of the aedeagus, but has each latero-posterior corner extended still further caudad into a roundingly pointed mesad curving projection. The aedeagus extends between the dorsal and ventral flaps of the theca and ends as a broad bilobed flap which shows between the curved ventral hooks of the theca. Attached somewhere near its base and extending externally between the flaps of the theca is a strongly sclerotized hook which abruptly bends cephalad and extends as far back as the base of the aedeagus. About two thirds of the way from the apex this aedeagal hook bears on its lateral margin a slender, slightly pointed hook.

Location of type. According to Melichar in the Museum in Budapest.

Notes on distribution. Dozier (1928) states that "this is a rare species, never collected anywhere in numbers." The type locality is Kentucky. In the Snow Entomological Museum is one specimen collected at Polk county, Arkansas, by Jack Beamer. In the National Museum collection are five specimens collected at Concan, Texas, by Mr. P. W. Oman.

VanDuzee's catalogue lists it in addition from New Jersey, Washington, D. C., North Carolina, Georgia, Kentucky and Missouri.

Thionia omani n. sp.

(Plates LI, LII)

ORIGINAL DESCRIPTION

Size. Length of body from apex of head to tip of tegmen, 7.2 mm. for the male. Length of tegmen, 6.2 mm.; width of tegmen through greatest width, 2.2 mm.

Color. General color golden-bronze. Vertex with the extreme outer margins dark brown, just inside of which is a narrow, light border, disk mottled brown with a light mesal spot anterior to center. Pronotum light brown, a yellow longitudinal stripe through middle of the depressed center and a dark-brown, small depressed spot on each side of this, each lateral half with about twelve light-yellow, uniformly sized pimples; mesonotum reddish-tan through middle, each lateral carina light yellow, laterad of which is a large brown spot, lighter at extreme sides and apex. Frons red-brown, extreme outside margins dark brown, median and lateral carina and many uniformly round spots and pimples, all light yellow. Clypeus reddish-tan, with basal or posterior margins and a broad median longitudinal band lighter tan. Eyes spotted in shades of brown. Venter of thorax yellow or reddish-tan. Sterna of abdominal segments dark brown through middle, light at the sides. Tegmina amber, translucent, infuscated in irregular spots or some small areas near apex light yellow; longitudinal and most of the cross veins deep tan, a few cross veins near apex light yellow.

Structural details. This is a broad-headed species with the apex of tegmina greatly narrowed and deflexed. Vertex broad, twice as wide as one lateral margin, its anterior margin triangularly produced at middle, its posterior margin triangularly emarginate, the baso-lateral corners of the frons distinctly showing from above. Pronotum roundingly produced anteriorly and shallowly emarginate posteriorly, its total width approximately six times its total length, greatly reduced in length behind eyes, due to the great overlapping of the head and eye region over the pronotum, the latter at this point being much grooved to allow for the insertion of the eye; all margins of pronotum being slightly raised, the disk through middle depressed and in exact center a pair of round, depressed spots. Mesonotum deeply depressed through middle, a faint median carina present and the two lateral carinae prominent. Frons a little over one third longer than basal or posterior margin, which is concave, the lateral margins slightly diverging at base of apical third, after

which point they extend apically and mesad in the form of a prominent thick carina, the space between the two ends of these margins being in width about half that of the basal margin; a median carina present on the frons, but abruptly ended half way of the length, two conspicuous lateral carinae also present, which start basally at the median carina, bow outwardly and end before apex of frons; the central disk of the frons thickly speckled with round, light-yellow spots, each lateral disk also speckled in yellow, but these spots usually more pimple-like. Clypeus approximating the lateral margins of the frons in length. Tibiae and femora of legs deeply sulcate. Tegmina very broad at base, prominently bullate at approximate apex of their basal fourth, from which point they strongly taper to an angulate apex and from about the middle of the wing on are distinctly reflexed; longitudinal veins and a few cross veins prominent, wing venation characteristic of the genus. Hind wings characteristic of the genus, being long, with vannal area large, and with a distinct notch in the prevannal area.

Comparative notes. This species is not easily confused with any other North American species. It is separated from *naso, producta, quinquata,* and *bullata,* by its broad vertex. From *simplex* it is separated by its much larger size and deeper coloring, by the angulate margin of its vertex instead of the rounded one of *simplex* and by its distinctly bullate and reflexed tegmina. From *elliptica* it is distinguished by lacking the strongly concave vertex with elevated lateral margins as in that species and by having more bullate tegmina, at which point they are widest, beyond which point they are greatly narrowed and reflexed at apex, while in *elliptica* the greatest width of the tegmen is through the apical region, and the margins are not bent under.

This species probably is more closely related to *Thionia variegata* Stål. The writer is not familiar with this species, but judging from Fowler's illustration of this species and his description, *variegata* is unicolorous, brownish-testacesus and does not possess the greatly narrowed, reflexed tegmina of *omani.*

The single specimen was sent to Mr. China of the British Museum, who compared it with Fowler's species of *Thionia* and *Colpoptera* material. He found that it did not compare with these and believed it to be a new species of *Thionia* belonging to the *variegata* group of Stål.

Location of type. This species was described from one male holotype, taken in the Organ mountains, Dona Ana, New Mexico,

August, 1915, collector unknown. The type is in the National Museum Collection, Washington, D. C.

The species was named in honor of Mr. Paul Oman, of the National Museum, who was the first person to recognize this as being a possible new species and who has done much collecting in this group of insects, as well as given much assistance to the writer in compiling this paper.

Thionia naso Fowler, 1905

(Plates LI, LII, LIII, LV, LVI)

Fowler, W. W. Fulgoridae, Biologia Centrali Americana. Homoptera I, pp 112-119, 1904.

AUTHOR'S DESCRIPTION

Size. Female, length of body from apex of head to tip of tegmen, 7.6 mm. to 8.4 mm.; length of tegmen, 5.6 mm.; width of tegmen, 2.4 mm. Male, length of body, 6.6 mm. to 7.2 mm.; length of tegmen, 4.8 mm.; width of tegmen, 2.3 mm.

Color. Resembling *producta* in general color pattern. Dull testaceous except most of ventral surface greenish-tan. Vertex with thin outer margins dark brown and on each lateral half a brownish longitudinal band which becomes darker at base, rest covered with dark-brown specks. Pronotum with a broad, median pale vitta, on either side of which it becomes darker; slender edges of the pronotum as well as some uniformly round, conspicuous dots, dark brown. Scutellum pale with three irregular brown spots on each lateral third. Frons yellowish-tan covered with prominent dark-brown spots; the basal angles and carinae, especially at base, black. Postclypeus for the most part dark brown with a conspicuous light vitta down center and a lesser one on each side. Genae, except at base and apex, ivory. Pleural flap of the pronotum with a light triangle on lower edge, which sends a slender wedge toward the eye. Tegmina considerably variegated and quite variable; the slender 2d A cell which extends along the entire claval margin, dark through middle; first anal cell conspicuously but irregularly clouded with dark; rest of tegmina with dark veins clouded with dark patches here and there; sternal regions light, marked with dark through middle and at the sides. Legs light, profusely covered by conspicuous dark-brown spots, some of which blend with others in places.

Structural characteristics. The vertex much longer than broad and greatly produced cephalad beyond the eyes; the basal portion nearly square, the apical portion extended forward in an acute angle to such an extent that one edge of the angle is equal to the lateral

edge of the basal region, making all five edges of the vertex approximately equal; sides carinate and an abbreviated carina on median line. Frons, elongate, slightly parallel through middle; basal and apical widths about equal; three longitudinal carinae present, converging at base and extending approximately four fifths of the length; posterior margin deeply emarginate for the reception of the clypeus. Clypeus elongate, strongly convex. Pronotum at middle about one half the length of the vertex, strongly advanced and obtusely angled between the eyes, truncated behind, ecarinate, with two impressed points on the disk. Mesonotum slightly longer than pronotum, its sides arcuated, a lateral carina faintly visible on either side. Tegmina slender, and costal margin angled as in *producta,* distinctly inflated at a point corresponding to apex of basal fourth. Venation characteristic of this genus, the longitudinal veins conspicuously elevated, cross veins few and indistinct.

Male genitalia. Since the general features of the male genitalia correspond to those in the species *producta* the reader is referred to the description of these structures under that heading in the discussion of that species.

Comparative notes. Since this species more closely resembles *T. producta,* the comparative notes given under this same heading in the description of that species will apply to *naso.* As is pointed out there, these two species can readily be distinguished externally. However, the matter is somewhat complicated when it comes to separating these two species by the male genitalia, for it is apparent that there is not much difference in these usually valuable characters. For this reason some writers might believe that it would be better to call one a variety than to leave them as two distinct species. The writer, however, has done the latter thing instead, mainly because of the idea that taxonomy in a large measure is a matter of convenience, and since the two are so easily separated by other characters it would seem less confusing to separate them into two species.

In the genitalia there are one or two minor differences (see drawings) which can be noted. The dorsoapical processes of the theca seem less pronounced in *omani* than in *producta.* Secondly, the apices of the aedeagal hooks in *producta* are always less sclerotized and seem more slender and tapering, so that at first glance they are easily not noticed. In *omani* these apices are more heavily sclerotized and seem somewhat bulbous at the end.

Location of types. Fowler described this species from one speci-

men collected by Dr. E. D. Ball at Jalapa, Mexico. Doctor Ball has this type now in his private collection. He has very kindly compared a male and female specimen with the type. These two specimens and about thirteen others have been taken at Concan, Texas, by Mr. Paul Oman of the United States Museum staff.

Notes on distribution. Doctor Ball wrote the following notation to the author after comparing the Concan, Texas, material with the type. "In reference to the species, it is typical *Thionia naso* Fowler as compared with the type and with material which I have from the Santa Rita, Huachuca and Chiricahua mountains."

Thionia producta Van Duzee, 1908

(Plates LI, LII, LIII, LV, LVI)

Van Duzee, E. P. Studies in North American Fulgoridae. Proc. of the Academy of Natural Sciences of Phil. LIX: 494, 1908.

Comparative notes. This species is easily distinguished from *simplex, elliptica, bullata,* and *quinquata* by the vertex, which is angulately produced cephalad for a considerable distance beyond the eyes. The basal portion is almost square, with the lateral margins parallel and slightly elevated as thin edges and the posterior margin shallowly and roundingly emarginate. The apical portion of the vertex, starting at the eyes, is produced cephalad in an angle, a little less than a right angle and each edge of which is about half the length of the lateral margin. The frons in this species is elongate, being not quite twice as long as wide and bearing three longitudinal carinae which are united at base, but which extend only approximately one half to two thirds of its length. The tegmina are narrower than in *bullata* and have the costal margin more angled.

T. producta more closely resembles *T. naso* Fowler than any others in the genus. From this species it is separated externally by its smaller size and the shapes of the vertex and frons. In *naso* the vertex is similar to that of *producta* at base, but has the apical region angulately produced cephalad to such an extent that one edge of the angle is much longer than either of the lateral margins or the length of the eye, while in *producta* this line is shorter than a lateral line or the length of the eye. The frons in *naso* is proportionally more slender, being over twice as long as wide and its width at base where the vertex and frons meet in an angle is approximately equal to that across its extreme apical margin, while in *producta* the basal width at this same point is less than the width at apex.

Notes on variation. This species seems very variable in color. In the original description much black was noted on frons, vertex, pronotum, and a broad vitta on the tegmina following the inner margins of the scutellum. In many specimens this black is greatly reduced or lacking in many places.

Structurally a variation is noted in the extent that the vertex is produced cephalad. A series of specimens show the vertex longer than in the typical forms, but not nearly as long as in *naso*. The writer places these longer-headed forms with *producta*, although Doctor Ball stated in a notation concerning *naso* Fowler that he had material of this species from the Santa Rita mountains, Arizona.

Male genitalia. The anal flap (tenth abdominal segment) in this species is so elongate that its apex bends caudad, snugly covering the extreme apices of the genital styli on the dorsal surface. Its length is a little longer than three times its width. At base the tenth segment is a flattened tube with parallel lateral margins. Its ventral margin extends caudad as the parallel-sided flap, which is truncate and slightly tapering at apex and not quite twice as long as the basal part. The eleventh segment is visible beyond its dorsal margin as a narrow ringlike segment bearing a moderately long stylus.

The harpagones (genital styli) are visible externally as broad, triangular plates whose inner margins are closely adjoined. From a flattened lateral view each harpago is a broad, pear-shaped plate, narrowed considerably at base, where it is attached to the body by a slender stalk. Its apex is considerably widened and its dorso-posterior region bears a foot-shaped flap which extends first caudad, then suddenly bends dorsad, where it projects dorsad as a roundingly pointed projection.

The aedeagal structure is similar to that of other species, especially that of *bullata*. It is bilaterally symmetrical. On the ventral side its posterior margin is truncate through the middle, but at the sides is deeply notched to allow the aedeagal hooks to appear externally as anteriorly projecting, well-sclerotized hooks. Laterad of the notches the theca projects caudad on either side as slender, somewhat pointed processes. From a lateral view it appears much longer, covering practically the entire aedeagus. Its extreme dorsal and apical region is modified into two projections, the anterior one being a rounding, cephalad-projecting lobe and the posterior one being a short, pointed, caudad-projecting hook. The aedeagus appears only at the extreme apex, where it appears as a broad, elongate lobe, emerging from between the flaps of the theca. It bears on each side

a long, narrow, well-sclerotized process which emerges from the notch of the theca, extends directly ventrad a short distance and then bends abruptly forward, reaching not quite to the base of the theca. Each aedeagal hook bears on its outer margin at approximately the base of the apical fourth a small external spine. *In situ* these hooks are crossed on the ventral side.

Notes on distribution. Van Duzee described this species from one pair taken at Rifle, Colo., in July. Mr. Van Duzee was kind enough to send to the writer a metatype male taken in the Huachuca mountains, Arizona, in August. Mr. Paul Oman has taken a series of fourteen at Concan, Texas, in June. In the Snow Entomological Museum at the University of Kansas is a large series taken in Arizona at the following places; Huachuca mountains, Santa Rita mountains, Yavapai, Prescott, Jerome, Miami, Coconimo county, Chiricahua mountains and Oak Creek canyon; and in Utah from Cove Fort, Cedar City, Monroe and Salina. In 1936 Dr. R. H. Beamer collected a series from Leakey, Texas, on July 8.

Location of types. In the collection of Dr. E. P. Van Duzee, San Francisco, Cal.

Host plants. Collected by Dr. R. H. Beamer from cedar (1936).

Thionia quinquata Metcalf, 1923

(Plates LI, LII)

Metcalf, Z. P. A Key to The Fulgoridae of Eastern North America With Descriptions of New Species. Jour. of the Elisha Mitchell Scientific Society 38; p. 190, 1923.

Comparative notes. Metcalf in his original description states that this species may be recognized by the shape of the vertex and by coloration.

The general color is almost uniform light brown, which is almost uniformly covered with small, dark points, and the veins are also dark.

In size it ranks as one of the larger species in the genus, as the female measures at least 8 mm. in length from tip of head to apex of wings.

The vertex is more distinctly chevronlike in shape than in any other species in the genus due to the sharper angles, especially the anterior one, and the fact that the six sides of the chevron are practically equal; the lateroanterior angles of the vertex are posterior to the anterior margin of the eye and, therefore, more of the frons is visible from above than in such species as *bullata*. The frons is broad as in *bullata*, being not much longer than wide; it bears three distinctly elevated longitudinal carinae, which are united at base;

its basal margin is only slightly concave. The longitudinal veins of the tegmina are prominent and elevated; the cross veins are more conspicuous than in other species.

Note. The writer was in possession of only one specimen for study. This was a female, and therefore no data in regard to the male genitalia can be given.

Notes on distribution. Metcalf states that the type female was collected at Raleigh, N. C., in September. One specimen in the United States National Museum was taken at Thompson Mills, Ga., concerning which no data was given in regard to date or collector.

Thionia bullata (Say), 1830

(Plates LI, LII, LIII, LV, LVI)

Say, Thomas. Jr. Acad. Nat. Sci. Phila. VI, p. 240; Comp. Writing, II, p. 375. Flata.

Comparative notes. A common species which is rather variable in color and, therefore, not always easily identified. The usual pattern has a light vertex marked with a dark longitudinal band on each lateral half (sometimes, however, reduced to a spot), which usually continues, although sometimes irregularly, across pronotum and mesonotum; tegmina unicolorous light brown or tan with a darker indefinite band in the form of a Y which is interrupted through the middle.

Size from tip of head to apex of tegmina 6.4 mm. to 7.6 mm.

The structural characteristics by which it can best be distinguished are the shape of the frons, the vertex and the tegmina. The frons is only slightly longer than wide; its lateral margins are roundingly and evenly emarginate, making the greatest width through apical third; it bears three distinctly elevated carinae which are united at base, and its basal margin is very slightly concave. This species resembles *quinquata* in many respects. It differs from it by its smaller size, shape of the vertex and tegmina. In the latter species the chevronlike shape of the vertex is more pronounced, due to the six sides of the chevron being approximately equal in length. In *bullata* the lateral margins are proportionally longer and this brings the lateroanterior angles in line with the anterior margin of the eyes or more commonly anterior to the eyes, while in *quinquata* this angle is posterior to the anterior line of the eyes. The tegmina of *quinquata* are distinctly inflated at base of apical fourth and only slightly so in *bullata*.

Male genitalia. Externally the male of this species can be distinguished very easily by the conspicuous spatulate projections from

the anal flap, which extend ventrad around the harpagones to such an extent that they almost converge at middle on the ventral side of the body. The tenth abdominal segment (anal flap) is conspicuously different from other members of the genus studied. At base it is a broad, flat tube, but apically it has its ventral and lateral margins projected caudad as a greatly expanded plate, whose lateroposterior corners are drawn out into long spatulate lobes (see above) and whose posterior margin through the middle is triangularly produced. The eleventh abdominal segment shows beyond the dorsal margin of the tubular part of the tenth segment as a short ringlike segment which bears an abbreviated stylus.

Externally the harpagones (genital styli of authors) appear on the ventral side of the body as two broad, triangular plates which closely adjoin along their mesal margins. As viewed from a flattened, lateral view, each harpago is a broad, pear-shaped plate, narrowed considerably at base where it is attached to the body by a slender stalk, but over twice as wide across the apex as at base and with a slender footlike flap extending first caudad, then suddenly bending dorsad as a roundingly pointed flap.

The aedeagal structure is of the *simplex* type. It is bilaterally symmetrical. On the ventral side the theca covers the aedeagus for three fourths of its length; it has a truncate posterior margin and each lateral third is extended laterally as a rounded flaplike lobe which is just caudad to the aedeagal hook at a point where it emerges from the notch in the theca. From a side view the theca shows a modification in the dorsoapical region, namely, by having two projections, an anterior one which is a rounded lobe that extends cephalad over the aedeagal structure for about half its length, and a posterior one which extends caudad and slightly dorsad as a slender, gently curving hook. The aedeagus shows as a thick lobe between the processes of the theca and bears two long, narrow, pointed processes, which protrude, one on each side, from the lateral notches in the theca and bend directly cephalad, extending as far forward as the base of the aedeagus. Each of these aedeagal hooks bears on its outer margin, at approximately the base of the apical sixth, a small external spine.

Notes on distribution. Say, in the original description, states that it inhabits the United States.

Specimens were available for study from Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi and South Carolina. In addition to these states, Dozier (1928) gives the following: New

Jersey, New York, Ohio, Pennsylvania, and Ontario. He states that both nymphs and adults were taken on oak.

Van Duzee's catalogue adds North Carolina.

Location of type. Do not know.

Thionia ocellata Melichar, 1906

Melichar, Leopold. Monograph des Issiden (Homoptera). Abk. k. k. Zoöl. Bot. Ges. Wein III, 1906.

Metcalf, Z. P. The Fulgoridae of Eastern North America. Jour. of Elisha Mitchell Society, Vol. 38: 158, 1923.

Comparative notes. The writer did not have any specimens of this species for study. Mr. Paul Oman says that there are no specimens in the National Museum, and that he is not familiar with the species.

Metcalf (1923), in his key to the species, distinguishes it by having vertex as long as broad, frons not arched, without a transverse yellow band, all reddish or yellowish-brown, vertex rounded anteriorly and tegmina with an ocellated spot near the apex.

The size of the species is given as 5½ mm.

Location of types. In the Wien Museum, Austria.

Notes on distribution. Apparently described from one female, for which the locality is given as North America. The writer believes that this species probably does not occur in North America, north of Mexico.

Thionia transversalis Melichar, 1906

Melichar, Leopold. Monograph des Issiden (Homoptera). Abk. k. k. Zoöl. Bot. Ges. Wien III, 1906.

Metcalf, Z. P. The Fulgoridae of Eastern North America. Jour. of Elisha Mitchell Society, Vol. 38: 158, 1923.

Comparative notes. The writer did not have any specimens of this species for study. Mr. Paul Oman says that there are no specimens in the National Museum and that he is not familiar with the species.

Metcalf (1923), in his key to the species, distinguishes it by having vertex as long as broad, frons slightly arched and with bright yellow transverse band.

The size of the species is given as 8 mm.

Location of type. Melichar states that the type female is in the museum in Wien, Austria.

Notes on distribution. The species was evidently described from one female, for which specimen the type locality is given as North America. The present writer is of the opinion that this is not found in North America, north of Mexico.

THE GENUS PICUMNA Stal

Stal, Carolus. Hemiptera Mexicana—Enumeravit Speciesque Novas Descripsit. Stet. Ent. Zeit. XXV: p. 53.

Fowler, W. W. Fulgoridae. Biologia Centrali Americana. Homp. I; 118-119, 1904.

Melichar, Leopold. Monograph der Issiden (Homoptera.) Abh. k. k. Zoöl. Bot. Ges. Wien III, 1906.

Comparative notes. In size varying from 6-7 mm. long. General color, brown, marked with testaceous and yellow.

Some of the distinctive characteristics of this genus are: the frons narrowed at base with one median carina distinctly visible and two lateral carinae faintly indicated or showing only at the extreme basal end; the clypeus keeled through the middle; vertex concave across disk; pronotum short with very abbreviated lateral areas, anteriorly curved and posteriorly straight; scutellum with three parallel longitudinal keels, the median one not always distinct; tegulae conspicuous; tegmina elongate, oval, weakly produced at sides and with thick longitudinal veins, the cross veins lacking or scarce, clavus long, extending to base of apical fourth of tegmen; hind wings long, deeply notched at margin; hind tibia with usually four lateral spines (rarely five) and a crown of spines at apex.

The wing venation in this genus shows the following characteristics: vein Sc is unbranched and, therefore, there is no expanded costal area; Sc_2 and R are united for only a short distance at base; M is always branched into two branches, usually about center of tegmen; vein Cu_1 is branched always posteriorly to the branching of M, but in various specimens varying in its distance from apex of tegmen; Cu_2 follows the anal suture; 1st A and 2d A uniting some distance from apex of clavus.

This genus resembles the genus *Thionia* rather closely, but is easily distinguished, as Stal points out, by its quadrispinose hind tibia and vein Cu_1 being branched; in *Thionia* the hind tibiae are bispinose and vein Cu_1 is simple.

KEY TO SPECIES

Ia. Dark brown, mottled with yellow; costal margins of tegmina as viewed from above not parallel, somewhat expanded at base so that greatest width of tegmen is in line with apex of scutellum............*Picumna chinai* n. sp., p. 478

Ib. Dark brown, mottled with yellow; costal margins parallel or slightly rounding, not expanded at base, greatest width of tegmina through middle. *Picumna maculata* (Melichar), p. 471

Picumna maculata (Melichar)

(Plates II, IV, V, VI, VIII)

Issomorphus maculatus Mel. Melichar, Leopold. Monograph der Issiden, Homoptera. Abh. k. k. Zoöl. Bot. Ges. Wien III, 1906.

Issomorphus maculataus Mel. Metcalf, Z. P. The Fulgoridae of Eastern North America. Jour. of the Elisha Mitchell Society XXXVIII, 1923.

Picumna ovatipennis Walker. Fowler, W. W. Biologia Centrali Americana. Homoptera I; 118-119, 1904. Figures a variety, fig. 30, plate 12, which may be *maculata* Melichar.

Comparative notes. *Issomorphus maculatus* in this paper is placed under the genus *Picumna* because it has all the characteristics of this genus. In appearance it is very similar to other species in the genus. Melichar in his original description of the genus *Issomorphus* mentions the presence of five spines on the hind tibia which he says separates it easily from the European genus *Issus*, and which would also separate it from any North American genus. The present writer has been unable to locate five spines on any specimen, and believes that Melichar must have counted the large lateral spines which make up part of the apical crown or circlet of spines.

This species in size and shape resembles very closely two Mexican species, *Picumna ovatipennis* Walker and *Picumna varians* Stal. In many collections the former name has been given to this species. It also resembles in color pattern and size *Picumna chinai* n. sp. For comparison of these species see the notes under this heading in the description of the latter.

A color variation occurs in this species, some specimens being much more mottled than others and some with uniform brown tegmina, except for a large yellow spot along the costal margin.

Male genitalia. The tenth abdominal segment (anal tube or flap) is a broad, flat tube at base that has its ventral margin extended caudad as a broad, spatulate truncate lobe which is wider across extreme apex. The eleventh segment shows beyond the dorsal margin of the tenth segment as a short, ringlike segment and bears a long, slender, pointed stylus.

Externally the harpagones (genital styli of authors) appear on the ventral side of the body as two triangular, pointed plates which are closely adjoined along their mesal margins. As viewed from a flattened lateral view each harpago is a broad pear-shaped plate, narrowed at base, greatly broadened out across apex with the dorsal, apical angle extended dorsad into an elongate process which is slightly pointed at its extreme apex and at base bears an external, liplike process.

The aedeagus and theca are difficult to distinguish. Together they appear as a bilaterally symmetrical, broad, tubular structure. From a lateral view the theca shows its apical margin broadly notched through middle, due to its ventral region being greatly extended caudad as a rounded lobe which bears on each side a rounded liplike process just posterior to each aedeagal hook, and its dorsal region extending caudad as three distinct processes, the one through middle being a broad semimembranous flap and the two on each side

being slender, sinuately curved, hooklike processes which are sharply pointed at apex. The apical region only of the aedeagus shows. This part consists of a broad, bilobed flap extending between the dorsal and ventral flaps of the theca, and two sclerotized hooks, one on each side, which protrude from the notches of the theca and immediately bend caudad for a short distance, then make a right-angled bend which causes them to extend cephalad over the aedeagus almost to its base. Each aedeagal hook, as viewed from the ventral side (drawing 3, plate LIV), is slender and cylindrical at base, then suddenly constricts to a narrow rod and then flattens out as a spatulate flap, bearing on its mesocephalic corner a slender, recurved hook.

Notes on distribution. Melichar lists Las Vegas, Hot Springs, New Mexico, as the habitat of this species. In the Snow Entomological Collection at the University of Kansas are many specimens taken by R. H. Beamer from the following places in Arizona: Coconimo county, Yavapai county, Oak Creek canyon, Grand Canyon, Huachuca mountains, Santa Rita mountains, the Chircahua National Monument, and Granite Dell. One specimen was collected by Mr. Beamer from Luna, N. Mex., in July.

Location of types. In the National Museum at Washington, D. C., are three syntypes of the species *Issomorphus maculatus* Melichar. Mr. Paul Oman has kindly made comparisons of these types and finds that two of them, although somewhat broken, fit the original description and figures made by Melichar for this species. One of these we are designating as the lectotype of the species. The data for this type is "Las Vegas, H. S., N. M., Aug. 13. Barber and Schwarz, collectors." According to Mr. Barber the H. S. means Hot Springs, which are at the base of the hills about six miles from the town of Las Vegas and in the edge of the pinon pine belt.

The third specimen of the group is the new species, *Picumna chinai*, which follows this description.

Host plants. Dr. R. H. Beamer collected a series of this species at Silver City, N. Mex., from pine (1936).

Picumna chinai n. sp.

(Plates L, LII, LIII, LIV, LVI)

Picumna ovatipennis Walk. Fowler, W. W. Biologia Centrali Americana. Homoptera I, pp. 118-119, 1904. (Probably is his figure 29, plate 12.)

Picumna ovatipennis Walk. Metcalf, Z. P. The Fulgoridae of Eastern North America. Jour. of the Elisha Mitchell Society XXXVIII, 1923.

ORIGINAL DESCRIPTION

Size. Length of body from apex of head to tip of tegmen 5.2 mm. to 5.6 mm. Length of tegmen 4 mm. to 4.4 mm.; greatest width of

tegmen 1.6 to 1.8 mm. This species has the size and appearance of *maculata* (Mel.).

Color. This species has the typical mottled color pattern in blackish brown to cream that is characteristic of the genus. Vertex, pitch-brown except for a median light tan longitudinal stripe and a spot of same color in center of each lateral half. Eyes, light brown or tan. Pronotum, pitch-brown except a median yellow stripe and the lateral carinae somewhat lighter. Mesonotum, light tan, mottled with light brown and all margins and carinae lighter. Frons, light tan, traversed by irregular tracings of dark brown which usually becomes a solid patch across basal or posterior margin and roundish spots on apical lateral corners, carinae brown. Clypeus, yellow, dark brown at sides, each lateral half bearing 6 to 7 oblique brown bands. Underside of thorax yellow with conspicuous dark-brown spots on each sclerite. Coxae of forelegs, light yellow, with a conspicuous brown spot on anterior half; femora of legs striped longitudinally in yellow and brown; tibiae reddish-brown; tarsal segments light, shading to reddish-brown on margins and into black-tipped claws. Abdominal segments of male from underside light yellow, harpagones infuscated. Abdominal segments of female from underside light at sides and margins, darker through middle; ovipositor valves pitch-brown. Tegmina, pitch-brown, irregularly mottled and speckled with light, a large semihyaline light spot on costal margin approximately at middle, which is somewhat triangular in shape, with the apex of the triangle directed mesad.

Structural details. Vertex transverse, concave, lateral margins slightly diverging posteriorly, anterior margin evenly rounding, but not angulate as in *maculata*, posterior margin deeply triangularly emarginate. Pronotum short, broader than head, slightly sunken through middle, shorter behind eyes and the anterior part of each lateral arm greatly sunken to allow for the overlapping of the eye onto it, behind which it is elevated into a sharp carina. Mesonotum triangular, not much broader than long, only slightly sunken through middle, median carina only faintly indicated, a lateral carina on each side conspicuous. Tegulae very large. Frons elongate, its lateral margins diverging apically so that at apex it is not quite a third wider than across the basal margin; the basal margin deeply concave; a median carina and a lateral carina on each side starting at the same place, slightly below the basal margin, the two lateral ones outwardly bowing and then running parallel with median one. Clypeus almost as broad at base as the frons, its greatest length about equal to one lateral margin of the frons. Tegmina held hori-

zontally on body, their claval and costal margins subparallel, their greatest width just anterior to middle, where they are considerably flared as viewed from above.

Male genitalia. Anal flap (10th abdominal segment) forms a characteristic flattened tube at base, the ventral margin of which is then extended into an elongate, parallel-sided, truncate lobe. The eleventh segment shows slightly beyond the dorsal rim and bears a slender, fingerlike stylus, which is many times longer than wide.

The harpago is extremely broad in this species, being almost triangular in shape. It is a flat lobe, slightly inflated through middle and with its extreme dorsoposterior corner extended cephalad into a somewhat bluntly tapering projection. At the base of this projection is a flat, external ventrad-projecting flap.

The aedeagal structure is bilateral and of the same general shape of *maculata*, but broader. From a lateral view the theca shows its apical margin broadly notched through middle, due to its ventral region being greatly expanded caudad as a rounded lobe, which bears on each side a rounded liplike process just posterior to each aedeagal hook, and its dorsal region extending caudad as three distinct processes, the one through middle being a broad semimembranous flap and the two on each side being slender, twice angled hooks which end in a sharp apex. The apical region only of the aedeagus shows. This part consists of a broad, bilobed flap extending between the dorsal and ventral flaps of the theca and two sclerotized processes, one on each side, which protrude from the notches of the theca, immediately bend caudad, then make a right-angled bend, which causes them to lie over the aedeagus, where they reach to almost the base of the latter. Each aedeagal hook as viewed from the ventral side is slender and cylindrical at base, then suddenly becomes slightly constricted, after which it suddenly expands, becoming a spatulate lobe with its mesocephalic angle forming a small, recurved hook.

Comparative notes. In collections of the Issidae taken in North America, north of Mexico, there are two species of this group represented in fairly good numbers. These two species have been determined by authors as *Issomorphus maculatus* Melichar and *Picumna ovatipennis* Walker, and have been indiscriminately and interchangeably classified as such. In order to straighten out which was which the writer sent specimens from each species to Mr. China, of the British Museum, to compare with the type of *Picumna ovatipennis* Walker. Mr. China reported that neither of these United

States forms were *ovatipennis* Walker, and sent a homotype (compared by him) of the latter to the writer for study. This homotype is described in the following description and figures are given for it. Mr. China suggested that the ovate United States species was *Issomorphus maculatus* Melichar and the other one, with the broadened tegmina at base, a new species.

Following Mr. China's comparison the writer then asked Mr. Oman, of the United States Museum, to again check over the type specimens. Mr. Oman reported that two of the three type specimens of *Issomorphus maculatus* Melichar were the ovate species and one was the broad-winged one. Because the ovate one fits Melichar's figure better we have designated it as the lectotype, and since it undoubtedly is *Picumna* we have changed the name to *Picumna maculata* (Melichar). See preceding description. The broad-winged form is herein described as new, with the name *Picumna chinai.*

The species of the genus *Picumna* resemble each other most closely in coloration and size. In these two respects *P. maculata* (Mel.) and *P. chinai* n. sp. are almost indistinguishable. Yet, these two are easily separated by the shape of the tegmina. *P. chinai,* as viewed from above, is a broad, flat species, more the shape of *Ulixes scutatus,* due to the great expansion of the wings at the base which makes the tegmina broadest at a point in line with apex of scutellum. *P. maculata* (Melichar) has the characteristic shape of the genus, which is ovate, as viewed from above, with the greatest width of the tegmina through the middle. The frons is slightly more narrowed at base and the clypeus slightly broader in *chinai* than in *maculata.* The genitalia of these two species are similar and yet show distinctive differences, which can best be seen by studying the drawings.

The Mexican species, *Picumna ovatipennis* Walker, is easily distinguished from the North American species occurring in the United States, by the shape of the vertex and frons. Although Walker described the vertex as transverse in this species, it is subequal in length and width, which gives it a much longer appearance. In *P. maculata* (Mel.) and *P. chinai* n. sp. the vertex is at least one fourth wider than long and has the appearance of being quite broad and short. The frons of *P. ovatipennis* is greatly narrowed at base and the clypeus much shorter than either of the other two species.

The writer has not seen any of the other Mexican species which might be confused with any of the above three. Mr. China believes, as does the writer, that both Fowler and Melichar thoroughly muddled up the genus *Picumna.* He states that *P. varians* Stal, as de-

termined by Fowler, seems to be closely allied to *ovatipennis* Walker. This idea is borne out by the fact that in Stal's description of *varians* he states that the vertex is equal in length and width.

Notes on distribution and types. The species was described from numerous examples taken at various points in Arizona. The species is named after Mr. China, of the British Museum, who has so kindly assisted the author in the identification of numerous species and who first suggested that this was a new species.

Holotype male and allotype female collected in the Santa Rita mountains of Arizona, on August 18, 1935, by R. H. Beamer. Paratypes from the following places: 14 females and 9 males from the Santa Rita mountains; 16 females and 11 males from the Huachuca mountains; 2 females and 2 males from the Chircahua mountains; 2 females and 2 males from Patagonia; one female from St. Catalina mountains, and two males from the Dragoon mountains.

Holotype and allotype, and the majority of the paratypes in the Snow Entomological Collection at the University of Kansas.

Picumna ovatipennis (Walker)

(Plate L)

Walker, Francis. List of the specimens of Homopterous Insects in the Collection of the British Museum. Supplement, p. 88, 1858, as (Issus).

Size. Length of body, 4.8 mm. Length of tegmen, 4.5 mm.; width of tegmen, 1.9 mm.

Color. General color greenish-tan, marked with brown. Vertex yellow through middle, lateral margins greenish, apical third and a spot in each lateroposterior corner brown. Frons, yellow-green, marked with dark in the following places; basal angles dorsad of carinae dark brown, lateral carinae faintly indicated almost to apex as brown lines which fade out apically, disk at base between lateral arms of carinae reddish-brown, followed by an irregular transverse band of light, another dark band through middle followed by a light area at apex; in each lateral disk through middle is a vertical row of about six round, brown spots, the expanded apical corner is mottled in brown. Clypeus greenish-yellow with six oblique bands indicated on either side, apical half dark brown. Genae yellow except a brown crescent around base of each antenna. Antenna dark brown with lighter brown sense organs. Pronotum greenish-yellow with two brown spots in apex of triangle formed by the lateral carinae and a brown spot at each extreme lateral edge. Pleural parts below yellow margined, rest dark brown except a light streak through middle. Rest of thorax below yellowish-green, splotched

with brown, from above light brown. Abdominal segments, from above light brown, at sides considerably darker and extreme posterior margins light. From below abdominal segments brown through middle, mottled at sides, extreme posterior margins greenish-yellow. Ovipositor dusky brown. Legs, femora brown with a broad transverse light band through middle; tibiae speckled; tarsal segments reddish-brown, somewhat darker on apices, tarsal claws dark brown. Tegmina yellowish-hyaline marked with reddish-brown in the following places: a broad triangle through middle with its apex ending on claval suture at about middle of wing, an oval spot on extreme apical costal angle, another large rectangular area between this spot and apex of corium, smaller spots scattered over other parts of corium, clavus with a larger, irregular oblique band across middle, a smaller irregular band posterior to this and the extreme basal posterior area dark brown. Wings pale, transparent with thick brown veins.

Structural details. Vertex with length and width equal, considerably concave through disk, making it appear narrower than it is, its anterior margins roundingly converging to a sharp pointed apex from above, thus allowing considerable of frons to show on either side. Width of eyes considerably greater than width of vertex. Pronotum considerably wider than head, distinctly triangulate anteriorly with its two lateral carinae converging to a sharp point as they touch the anterior margin. Mesonotum large, slightly over twice the length of the pronotum at middle, a transverse crease following along the anterior margin and ending on each side at the lateral carina, no median carina visible, the central disk somewhat depressed. Abdominal segments collapsed in the dried specimen. Anal flap (10th segment) long, the extended flaplike part about one third longer than the tubular part. Genital stylus of the eleventh segment, a long, slender, fingerlike projection. Tegulae conspicuous. Tegmina subparallel, margined with the costal margin only slightly rounding, apex uniformly rounding, and its greatest width, if any, in line with angle of the claval margin. Hind wings large, with its three areas at apex about equal in width.

Wing venation same as for the genus in general characteristics. In particular, M branches into two branches considerably anterior to middle, then each branch again divides in the apical region. Cu_1 branches only a slight distance posterior to middle; anal veins unite at about base of apical fourth of clavus.

Comparative notes. This Mexican species apparently has not been collected north of Mexico at the present time. Two or three

northern species have been wrongly determined as this species in collections and in the literature. For comparative characters to separate the several species see the notes under this heading in the description of *Picumna chinai* n. sp., just preceding.

Mr. China very kindly loaned the writer a female homotype compared by him with the type. Drawings of this specimen are found on plate L, figs. 1, 2, and 3. In studying this type specimen with Walker's description the present writer finds the following inconsistencies in the description: Walker states that the vertex is transverse, whereas, in the specimen it is subequal in length and width; that the abdomen is black—in this specimen it was testaceous brown; that the forewings are black and tawny towards the base—in this specimen they are tawny with brown markings; that the forewings have a tawny mark on the anterior border—this specimen had a large costal spot which also continued transversely across wing; that hind wings are grayish vitreous with black veins, while here they are pale yellow with light-brown veins.

Location of types. British Museum.

THE GENUS EUTHISCIA Van Duzee

Van Duzee, E. P. Expedition California Academy of Science to Gulf of California. Proc. Cal. Acad. of Sc. XII, p. 193, 1923.

Comparative notes. According to Van Duzee this genus has the aspect of *Mycterodus* and is closely allied to *Thiscia* Stal. Neither of these genera are North American. It differs from *Thiscia* by the very broad, smooth front, much simpler elytral venation and the rudimentary wings.

The genus is readily distinguished from other North American genera by spineless hind tibiae, the very large pronotum as compared to the scutellum and the broad, much abbreviated and somewhat bullate tegmina which enclose the body and meet below it.

Van Duzee described two species in the genus, of which one species, *Euthiscia tuberculata*, has been taken north of Mexico by Dr. E. D. Ball, at Tucson, Ariz.

Euthiscia tuberculata Van Duzee, 1923

(Plates I, IV, V, VI, VIII)

Van Duzee, E. P. Expedition California Academy of Science to Gulf of Mexico. Proc. Cal. Acad. of Sc. XII, p. 193, 1923.

Comparative notes. This species is readily distinguished externally by several characteristics. On the dorsum of the body are six tuberculate elevations, two on vertex, two on pronotum and two on the scutellum. The tegmina are unusual because of their shape and

brevity; being so abbreviated at apex that little of the tegmen extends caudad beyond tip of clavus and their greatest width is at a point considerably cephalad to their middle. As is typical for the genus the tegmina are held vertically, are somewhat bullate, and enclose the body by having their costal margins meet below.

The wing venation shows the following general characteristics: vein Sc divided, with vein Sc_1 (equal costal vein of Metcalf) only visible a short distance at base; veins Sc_2, R, M and Cu all apparently united at base for a short distance; veins Sc_2 and R branching from this main trunk as one vein, but soon dividing into separate veins; vein M four-branched; vein Cu_1 two-branched; vein Cu_2 running along claval suture as in other Homoptera; veins 1st A and 2d A by uniting at apex forming a Y-vein in clavus. All the veins of the tegmina breaking up into a reticulation at apex so that it is difficult to trace out the course of the longitudinal veins. Hind wings lacking.

Male genitalia. Anal flap (10th abdominal segment) almost three times as long as broad, narrowed at apex. Eleventh segment ringlike and with a conspicuous elongate stylus. Both of these segments almost hidden externally, due to the great compression of the abdominal segments and the dorsal extension of the apices of the harpagones.

The harpagones in this species are visible externally as two ventral subrectangular plates meeting at middle. They are proportionally smaller than in other species in the subfamily. Due to the great compression of the sterna of the abdominal segments they assume, also, a more vertical position with their apices extending considerably dorsad, thus crowding the anal flap and genital stylus backward until the latter touch the abdominal terga and are practically hidden by the harpagones.

The aedeagus is a broad tubular structure which is bilaterally symmetrical. Its apical half is divided into two broad spatulate lobes, each of which bears four irregular teeth on its laterocaudal margin and on its ventral side a cephalad-projecting, sharply pointed, elongate flap, which extends cephalad to a point midway the length of the aedeagus. A broad, three-pronged apodeme is attached to the base of the aedeagus. A rather complicated theca envelops the aedeagus. On the ventral side the theca, through the middle, covers the aedeagus for about two thirds of the length of the latter, but the extreme lateral angles project caudad much farther and somewhat dorsad as two sharply pointed processes. On the dorsal side the theca is more membranous, is depressed through the middle for

most of its length and at the apical end projects caudad between the apical flaps of the aedeagus as a broad, somewhat pointed process. (See drawing 9, plate LIV.)

Notes on distribution. The species was described from numerous examples from lower California. Holotype male taken at Los Angeles Bay and allotype female at Monserrate Island. Types are in the California Academy of Science Collection at San Francisco. Dr. E. D. Ball has since taken this species from a gray shrubby Verbena (*Lippia wrightii*) in Sabino canyon, near Tucson, Ariz.

THE GENUS HYSTEROPTERUM Amyot and Serville

Amyot and Serville. Hemip. p. 519, 1843.

Fowler, W. W. Fulgoridae. Biologia Centrali Americana. Homoptera I, pp. 113-119, 1904.

Distant, W. L. Fauna of British India, Family Fulgoridae. Rhynchota III, p. 333, 1906.

Melichar, Leopold. Monograph der Issiden (Homoptera). Abh. k. k. Zoöl. Bot. Ges. Wien, III, pt. 4, 1906.

Metcalf, Z. P. The Fulgoridae of Eastern North America. Jour. of the Elisha Mitchell Society XXXVIII, 1923.

Dozier, Herbert L. Fulgoridae. Miss. Agric. Exp. Sta. Bull. 14, 1928.

Comparative notes. The distinguishing characteristics of this genus are: Tegmina short, either subequal in length and width or not twice as long as wide, deflected in an oblique or vertical position to the body, not convex, narrowed and rounded at apex; costal margin narrow, bent at an angle to rest of wing and lying horizontally against venter; hind wings small and rudimentary; head not porrectly produced in front of eyes; frons centrally and laterally carinate; hind tibia either with one or two stout lateral spines; male genitalia bilaterally symmetrical.

The general features of the venation are: vein Sc_1 close to costal margin and from a dorsal view appearing to be the ventral margin of the tegmen; veins R and Sc_2 united a very short distance at base, each single vein parallel throughout rest of wing; vein M divided into two branches near middle of wing; vein Cu_1 simple; vein Cu_2 following the anal suture; veins 1st A and 2d A united near apex to form the characteristic Y-vein of the clavus. All the longitudinal veins break up into a close reticulation at apex of wing.

KEY TO SPECIES

1. Larger insects, measuring 6 to 7 mm. long; dark brown or blackish in coloring; reticulate elytra.............................*morum* Van Duzee, p. 482
   Smaller insects, measuring under 5 mm. in length; varying from speckled dark brown to light cream in coloring................................ 2
2. (1) In lateral view dorsal line of tegmen straight; usually uniformly colored, marked with numerous dark spots in the cells of the tegmina (occasionally two-toned) 3

Somewhat concave through middle; either contrastingly colored in fuscous and light or cream, spotted with dark in varying degrees.............. 5

3. (2) In dorsal view frons protruding almost equal to length of vertex, lateral carinae against eyes scarcely elevated; disk of vertex less concave; anterior margin of pronotum rounded; lateral edge of tegmen cream colored ....*auroreum* Uhler, p. 483

In dorsal view frons protruding not as much as half length of vertex, lateral carinae against eyes distinctly elevated; disk of vertex concave, anterior margin of pronotum angulate; tegmen without a cream band............ 4

4. (3) Vertex with lateral margins greatly elevated; its width only twice as great as length; hind tibia with one lateral spine......*fuscomaculosum* n. sp., p. 485

Vertex over twice as wide as long; lateral margins moderately elevated; hind tibiae with two lateral spines....................*punctiferum* Walker, p. 487

5. (2) Tegmen slender, almost twice as long as broad; strongly marked in contrasting light and dark patches; back concave, but no pyramidiform elevations of the tegmina....................................*unum* Ball, p. 489

Tegmen short and broad; more uniformly colored, varying from cream with few black spots to dark brown or gray with many dark spots; some form of pyramidiform elevations on clavus................................. 6

6. (5) Slightly larger insects measuring 3.5 to 4 mm. in length; frons with a single median longitudinal disk narrower than either lateral disk; pronotum longer and with margins against eye elevated...........*bufo* Van Duzee, p. 491

Slightly smaller insects, measuring 3 to 4 mm. in length; frons with a single median disk wider than a lateral disk; pronotum shorter and lateral margins not elevated against eye....... 7

7. (6) Vertex with anterior margin concave through middle, making its length at this point only one half the length of the lateral margin; angle of vertex and frons above eye sharp; and from above this angle in position anterior to front line of eye; claval elevations prominent........*sepulchralis* Ball, p. 492

Vertex with anterior margins broadly, sinuately convex, length at median line not much shorter than at lateral margin; angle of vertex and frons rounding; and from above this angle in position posterior to front line of eye; claval elevations, especially at apex, scarcely visible or lacking........ .. 8

8. (7) Pale creamy in color; elevations on clavus scarcely noticeable; size smaller, 3 mm. ....*cornutum* var. *cornutum* Melichar, p. 493

Much darker, nearer like *sepulchralis* in color; claval elevations slightly longer and more distinct; size 3 to 3.5 mm........*cornutum* var. *utahnum* Ball, p. 495

Hysteropterum morum Van Duzee

Van Duzee, E. P. Expedition Cal. Acad. of Sci. to Gulf of California. Proc. Cal. Acad. of Science 12; p. 191, 1923.

Comparative notes. The author has not seen this species. Apparently it is a rare species for this country. Van Duzee described it from one female taken at the bay at the southern end of Tiburon Island, in the Gulf of California, and from one male taken on the Rinco mountains, in Arizona.

Van Duzee himself distinguishes it by saying that it is a large blackish species with much the aspect of *Picumna ovatipennis* Walker, but that it is distinct structurally. He gives the size as being from 6 to 7 mm. in length. In his description he also points out that it resembles *Hysteropterum fowleri* Fowler, a Mexican species, but is darker than that species with a more convex clypeus.

Mr. Paul Oman, in a note to the author, states that *H. morum* is close to *Thionia naso* Fowler, but has reticulate elytra and a shorter vertex than that species has.

Location of types. Female is No. 1805, Mus. Cal. Acad. Sci. Male is in collection of E. P. Van Duzee.

Hysteropterum auroreum (Uhler), 1876

(Plates LVII, LVIII, LIX)

Uhler, P. R. List of the Hemip. of the Region West of the Mississippi River, Including Those Collected During the Hayden Exploration of 1873. Bull. U. S. Geol. Geog. Surv. I, p. 352, 1876.

Comparative notes. Superficially this species closely resembles *H. punctiferum,* both in color and size. The ground color in this species is a brighter yellow and the markings of dark on the tegmina, especially on the clavus, are more in the nature of blotches than dots as in *punctiferum.* The size of both species is 5 mm. Structurally *auroreum* differs from *punctiferum* by the following characteristics: in the former the frons, as viewed from above, shows beyond the vertex for almost half the length of the vertex, while in the latter it is scarcely visible; in *auroreum* only the median carina of the frons is conspicuous and the rest of the disk is smooth and even slightly convex, while in *punctiferum* three carinae are distinctly visible and the disks between are concave; in *auroreum* the basal margin of the frons is almost straight and the apical one deeply emarginate to receive the large clypeus, but in *punctiferum* the basal margin is convex, and the apical margin much less indented.

Male genitalia. The genitalia of this species very easily distinguish it from any allied species. The anal flap (10th abdominal segment) usually reaches only to the tips of the styli, so that from a ventral view it is not visible beyond them. From a flattened dorsal view the 10th segment appears much narrower through the basal, flattened tubular part; thence the expanded ventral margin broadens fanlike into a fanlike flap which extends caudad a distance which equals the length of the basal tube, after which its margins abruptly constrict to a rounded, narrower apex. The eleventh segment shows only as a narrow rim beyond the dorsal margin of the anal tube and bears an abbreviated stylus.

The harpagones (genital styli) are visible externally as sharply pointed triangular plates. From this external ventral view each harpago is twice as long as its width at base. From a flattened

lateral view each harpago is roughly pear-shaped. Its narrowed anterior end is the point at which it is attached to the body. Through the apical region it is broadened to over twice its width at base. The posterior dorsal angle is prolonged cephalad into a sharply pointed, slightly recurved hook. At the base of the expanded dorsal corner is a short, broad, triangular, external hook whose apex bends caudad.

The theca in this species closely ensheathes the aedeagus as a tubular sheath for about two thirds its length. At this point it splits on each side; the dorsal half then extends caudad to the full length of the aedeagus and becomes bulged out at the apical end into a bulbous flap, one on each side, lying above the aedeagus; the ventral part of the split theca extends below the aedeagus as a bluntly tapering single flap which ends in a point some distance anterior to the apex of the aedeagus. The aedeagus shows only between the split ends of the theca as a thickly tubular structure which bears at its extreme apex on each side a well-sclerotized triangular hook, only part of which is visible externally, and two conspicuous, long, well-sclerotized processes which emerge, one on each side, from the notches in the theca and extend anteriorly to the base of the aedeagal structure.

Female genitalia. In this species, as in others in the genus, the external female genitalia are of some taxonomic importance. The anal flap (10th abdominal segment) is large. It extends well beyond the tips of the ovipositor valves and in many cases folds ventrad around the valves, completely hiding their tips. From a flattened dorsal view it appears as a broad wedge-shaped flap with its lateral margins strongly, outwardly curved and with the tubular basal region about half as wide as the expanded apical flap. The eleventh segment is represented as a minute ringlike structure, only barely visible beyond the dorsal margins of the tube. It bears a small, pointed stylus.

The eighth abdominal segment is hidden under the seventh. The ninth segment is conspicuous. The seventh segment has its posterior margins concavely rounding and its anterior margin angulately produced cephalad.

Notes on distribution. In the original description Uhler states that this species inhabits Texas. The specimens available for study were all from Texas.

Location of types. In the United States National Museum at Washington, D. C.

Hysteropterum fuscomaculosum n. sp.

(Plates LVII, LVIII, LIX)

ORIGINAL DESCRIPTION

Size. Length of body from apex of head to tip of tegmen, 2.8 mm. to 4.3 mm., averaging around 3 mm. Length of tegmen, 2.4 mm. to 3.6 mm. Width of tegmen, 1.4 mm. to 2 mm.

Color. Same general color as *punctiferum* Walker. Body color amber yellow. Vertex with lateral and anterior margins etched in dark brown, a faint median dark-brown line, a dark spot in each lateral half against the anterior border. Eyes mottled brown. Disks of frons between carinae uniformly dark brown or somewhat mottled, lateral disks lighter, mottled with dark spots; carinae and part of lateral margins light. Clypeus brownish through middle, crossed with darker oblique bands, median carina and anterolateral corners light. Pronotum yellow, median light stripe, rest dotted with brown spots. Mesonotum with borders and apex light, rest fuscous-brown. Tegmina uniformly amber-yellow, conspicuously dotted with small round brown spots in the cells, the veins light. Prothorax and mesothorax tannish to brownish with margins always light. Metathorax yellow or green. Legs amber or light yellow, coxae and tibiae with longitudinal brown stripes or markings, femora crossed by two to three transverse brown bands. Abdominal segments green or yellow, with usually a median brown spot against anterior margin and two transverse rows of uniformly round dots across disks of each segment, or else a cluster of round spots through middle.

Structural characteristics. Shape of *punctiferum* Walker, but with head and thorax proportionally narrower in comparison with greatest width across the combined tegmina. Vertex somewhat wedge-shaped with greatest width across its anterior margin, its width at this point exactly twice greater than the length at lateral margins, its posterior margin elevated. Frons narrowed at base, its basal margin moderately convex, a distinct median carina present and two slightly arching lateral carinae, each median disk twice as wide at basal end as either lateral one, but about equal in size with each lateral one at extreme apical end, apical margin deeply emarginate to receive clypeus. Clypeus moderately inflated with a distinct median carina present.

Pronotum in length at middle subequal to a lateral margin of vertex, greatly reduced in length behind eyes. Mesonotum slightly longer through middle than the pronotum, a transverse crease par-

allel with and close to anterior margin, a diverging oblique carina on each lateral disk. Tegmina not quite twice as long as its greatest width, which is at a point halfway of complete length of the insect, slightly more inflated at this point than in *aciculatum;* anal margin straight, posterior margin obliquely sloping from apex of clavus, costal cell and part of Sc_1 inflexed against venter. Wing venation characteristic of the genus, the longitudinal veins thick, little reticulation at apex.

Male genitalia. Genital segment (10th abdominal) short and not visible from a ventral view. It is a flattened, tubelike segment at base and has its ventral posterior margin extended into a bluntly tapered flap, which is about one third longer than the basal part. The eleventh segment shows beyond the dorsal posterior margin of the tube as a small, ringlike segment, which bears an inconspicuous, short, fingerlike stylus.

The harpagones (genital styli) are visible externally as sharply pointed, triangular plates which meet along their inner margins. From a flattened lateral view each harpago is roughly pear-shaped, very much narrowed at its anterior end, where it is attached to the body. The posterior margin is greatly widened and has its dorsal corner elongated dorsad into a slender anteriorly recurved hook. At the base of this dorsal extension is a narrow, liplike, external hook, whose free margin is directed ventrad.

The internal genitalia are bilaterally symmetrical. The theca extends for a short distance from base as a tubular sheath for the aedeagus, then on each side it splits longitudinally. The dorsal part continues caudad as a flap, which through the middle third extends downward on either side as a phlange in front of the aedeagal hook, but apically splits at the middorsal line, thus terminating on each side in two lobes, the dorsal one of the two being a long slender spatulate process which reaches to the apex of the aedeagus, the ventral one a short, bluntly pointed hook. The ventral part of the theca extends caudad as a single broad, slightly tapering plate which very nearly extends to the apex of the aedeagus. From a lateral view the apex of the aedeagus shows between the dorsal and ventral lobes of the theca and a slight portion of it shows dorsad of the theca. It shows also a well-sclerotized basal hook which emerges from the notch in the theca and is sinuately curved cephalad.

Female genitalia. Externally the genital plates and ovipositor valves are of taxonomic importance. Very little of the valves show externally, being partly covered by the seventh abdominal segment,

which is triangularly produced through the middle. The seventh segment in this species differs considerably in shape from that of *aciculatum* (see drawings). The genital segment (10th abdominal) is elongate and extends a considerable distance beyond the apices of the valves. The tubular basal part is short, but the extended ventral flap is much longer than in other species and has its lateral and apical margins deeply reflexed, so that through the apical region the flap is half of the basal width. The eleventh segment shows beyond the dorsal posterior rim of anal segment as a narrow, ringlike segment which bears a short stylus.

The eighth and ninth abdominal segments are invisible. The posterior margin of the seventh is triangularly produced caudad, so that the segment is much longer through the middle than at the sides.

Comparative notes. This species more closely resembles *H. punctiferum* than any other species in the genus. For comparison of these two species see the notes under this heading in the discussion of *H. punctiferum* Walker.

Location of types. Holotype male, allotype female, collected August 2, 1930, at Likely, Fla., by R. H. Beamer. Twenty-nine paratypes from Likely, Fla., July, 1934, and August, 1930, collected by R. H. Beamer, and eleven paratypes from Fort Pierce, Fla., August 30, two from Lighthouse, Fla., August 2, 1930, and one from Estero, Fla., July 21, 1934, by the same collector. These types are in the Francis Huntington Snow Entomological Collection at the University of Kansas.

Hysteropterum punctiferum Walker, 1851

(Plates LVII, LVIII, LIX)

Walker, Francis. List Homop. II, p. 376, 1851.

Uhler, P. R. List of the Hemiptera of the Region West of the Mississippi River, Including Those Collected During the Hayden Exploration of 1873. Bull. U. S. Geol. Geog. Surv. I, p. 353, 1876. Described as *H. ac ulatum* n. sp.

Melichar, Leopold. Monograph der Issiden (Homoptera) Abh. k. k. Zool.-Bot. Ges. Wien, III, pt. 4, 1906.

Comparative notes. Walker's description of this species is not very clear. Uhler, on the other hand, gives a very comprehensive and easily followed description. The writer was in some doubt as to whether they were synonymous. Mr. China of the British Museum, however, made an accurate comparison of some recently collected specimens and found them to be identical with the type specimen of Walker's *punctiferum* collected at St. John's Bluff, Fla.

H. punctiferum Walk. is distinguished as follows: short, robust, minutely punctate with fuscous; its length, 5 mm. It resembles

H. auroreum Uhler somewhat, but differs by having the frons showing only a very little beyond the vertex as viewed from above; by the frons being distinctly tricarinate and with its basal margin convex and the apical margin shallowly indented to receive the clypeus. This species is more closely allied to *H. fuscomaculosum* than any other. They both have the same amber color, minutely punctate on tegmina with brown flecks. They differ structurally, however, in the shape of the vertex, size, spines on the tibiae and in the genitalia. In *punctiferum* the vertex is well over twice as wide as its length through middle and its lateral margins are not elevated, while in *fuscomaculosum* its width is only twice its length and the margins are elevated against the eyes. The length of *punctiferum* is 4 to 5 mm.; for *fuscomaculosum* 3 mm. The head and thorax of *punctiferum* are proportionately wider than in *fuscomaculosum*. *Punctiferum* has a bispinose hind tibia and the other is unispinose. The females of the two species show differences in the shape of the apical abdominal segments. In *fuscomaculosum* the seventh abdominal segment is triangularly produced through middle and the ovipositor valves are partially hidden. In *punctiferum* the seventh abdominal segment is broadly produced through middle and parts of the ninth abdominal segment, as well as the valves, are exposed. The anal flap (10th abdominal segment) is much narrower at the apex, due to the deeply reflexed apical and lateral margins.

Male genitalia. The tenth abdominal segment (anal flap) is more visible externally than in *H. unum*, but as in that species it is not as conspicuous as in the female. It is a flattened tube at base, whose ventral, apical margin is expanded into a large flattened flap. The lateral margins of the flap are bulged out through the middle, then are abruptly constricted to form a narrowly rounded apex. The eleventh segment shows beyond the dorsal edge of the anal tube as a narrow rim and bears a short, pointed stylus.

The harpagones (genital styli) are visible externally as sharply pointed triangular plates. From this external ventral view each harpago is about twice as long as broad. From a flattened lateral view each one is roughly pear-shaped, narrowed at its anterior end where it is attached to the body, very much broadened across its posterior margin, where the dorsal posterior angle is projected dorsad as a slenderly recurved hook. At the base of this dorsal extension is a narrow, liplike, external flap, whose free margin is directed ventrad.

The theca and aedeagus of this species are difficult to separate, since the theca fits snugly around the aedeagus as a tubular sheath

with flaplike extensions. The entire structure is bilaterally symmetrical. From a side view most of the aedeagus is hidden. The theca extends for a short distance from base as a tubular sheath for the aedeagus, then on each side it splits longitudinally. The dorsal part continues caudad as a flap, which through the middle extends downward on either side as a phlange in front of the aedeagal hook, while the extreme apical third is greatly narrowed, and splits longitudinally on the dorsal side to form two elongate, spatulate flaps, whose dorsal margins are serrate. Ventrally the theca extends caudad as a single broad, slightly tapering plate which does not completely reach the apex of the aedeagus. The aedeagus shows slightly at the apex as a truncate lobe between the dorsal and ventral flaps of the theca. It also shows a semicircular, well-sclerotized hook which emerges from the notch in the theca near its base, bends directly cephalad a short distance and then curves caudad and ventrad, forming a semicircle.

Female genitalia. The anal flap of the female is more conspicuous than that of the male. It extends beyond the tip of the ovipositor valves to a greater degree than in *H. unum.* (See plate LIX, drawing 16.) From a flattened dorsal view it is broader at base, where it is a flattened tube. Beyond this tubular base the ventral margin is expanded into a roundingly tapering spatulate flap bearing numerous long, stiff hairs. The eleventh segment is inconspicuous and ringlike, showing only to a slight extent beyond the dorsal edge of the anal tube proper. It bears a very short, buttonlike stylus.

The seventh abdominal segment is longer than in most species. It has a sinuate posterior margin which is convex through middle. The lateral parts of the ninth segment are visible; the eighth is hidden under the seventh.

Notes on distribution. Type locality is St. John's Bluff, E. Florida. Uhler states that it inhabits Orange Spring, Fla., and Texas. In addition to many Florida specimens the writer had available for study specimens from Okefenokee Swamp, Georgia.

Location of type. British Museum of Natural History.

Hysteropterum unum Ball

(Plates LVII, LVIII, LIX)

Ball, E. D. New Genera and Species of Issidae (Fulgoridae). Proc. Biol. Soc. Wash. XXIII, p. 48, 1910.

Comparative notes. This species is a strikingly marked species. The vertex is light with a pair of brown V-shaped marks in the posterior angles. The front is dark except for the lighter carinae,

margins and a few irregular spots. The elytra show contrasting light and dark patches somewhat as follows: at base the clavus is either entirely dark or bears an irregular brown capital L, posterior of which the entire apex is creamy white, forming, when combined with other tegmen, a conspicuous diamond-shaped marking in the middle of the combined tegmina; an oblique, arcuated dark-brown band takes up most of the corium; many of the lighter cells with dark specks in them.

Structurally the species is characterized by the vertex, which is not produced beyond eyes, but is two and one-half times wider than long; the frons is tricarinate and has its basic margin deeply convex; the clypeus is not deeply dovetailed into the frons and bears a strong median carina; back concave through middle; elytra longer than in most species, being not quite twice as long as broad.

Male genitalia. The anal flap (10th abdominal segment) is much less conspicuous than that of the female. At base the tube is somewhat constricted, then enlarges through middle, from whence it again narrows to a truncately rounded apex. The eleventh abdominal segment is ringlike, showing only slightly beyond the dorsal posterior edge of the tenth segment, and bears a short, pointed apical stylus.

The harpagones (genital styli) are visible externally as broad, triangular lobes that meet at middle in a straight line. From this ventral view each harpago is about one third longer than its width at base. From a flattened lateral view (see plate LIX, drawing 13) each harpago is a somewhat pear-shaped plate, which is attached at its anterior end only where it is narrowed considerably. It is very much broadened across its apex and has its dorsal, apical corner prolonged cephalad into a slightly cephalad-curving spatulate lobe, at the base of which is an external, raised, liplike flap.

The aedeagal structure is unique for the genus. It is bilaterally symmetrical. The theca forms a close-fitting tubular sheath extending practically the entire length of the aedeagus. On each side the apical half of the theca bears a longitudinal slit, from which arise the aedeagal hooks. The anterior aedeagal hook arises from the base of the slit and extends anteriorly as a forked process, the dorsal arm of which is shorter than the ventral one. The posterior hook of the aedeagus arises from the extreme apex of the aedeagus as a broad spatulate flap which extends dorsad and somewhat anteriorly. (See plate LVIII, drawing 13.)

Female genitalia. The anal flap of the female is large and very conspicuous. It is held vertical to the body so that it very nearly

meets the ovipositor valves on the ventral side of the body. From a flattened dorsal view it shows its lateral margins evenly rounding to a broad, rounded apex. The eleventh abdominal segment is not visible as a rule externally. The stylus of this last segment is long and slender.

The seventh abdominal segment is the last visible abdominal segment. It is characterized by having a sinuate posterior margin which is slightly concave through middle.

Notes on distribution. This species was described by Dr. E. D. Ball from a single male taken near Pueblo, Colo. Specimens were available for study from Socorro county, Carlsbad, Alamagordo, and Rodeo, New Mexico, and from Marfa and Brewster county, Texas.

Location of types. Collection of Dr. E. D. Ball, Tucson, Ariz.

Hysteropterum bufo Van Duzee, 1923

(Plates LVII, LVIII)

Van Duzee, E. P. Expedition to the Gulf of California. Proc. Cal. Acad. of Science 12: p. 92, 1923.

Ball, E. D. Some New Issidae, With Notes on Others. Bull. Brook. Ent. Soc. XXX (2): 87, 1935.

Comparative notes. This species measures 3.5 to 4 mm. in length. The following color description is given in the original description: "Color, most variable, grayish testaceous and fuscous, sometimes nearly black or varied with green on head and pronotum, usually with a paler area at apex of front; elytra pale or brown with fuscous veins and dots in the areoles." Structurally, according to Doctor Van Duzee, it is allied to *cornutum*, but is distinguished by its narrower front and longer pronotum. The writer finds that it is readily separated from both *cornutum* and *sepulchralis*, which it closely resembles, by the following characteristics: it is larger than either of these species, being usually around 4 mm. long; the angle formed by the union of the vertex and frons is more acute and prominent; the pronotum is longer and has its margins against the eye elevated; the elevations on the clavus are more conspicuous; and the longitudinal carinae on the frons are closer to the median one so that on each side the median disk is distinctly narrower than the lateral one.

Genitalia. No male specimens were available for study.

The anal segment of the female very closely resembles that of *H. sepulchralis.* The seventh abdominal segment is of the same shape as *cornutum* and *sepulchralis.*

Notes on distribution. The type specimens were collected in the

Gulf of Mexico region on Lycium. Dr. E. D. Ball (1935) gives the first North American record for this species. He took a single female at High Tanks (Tinajas Altas) in Arizona, near the Mexican border. Doctor Ball sent the writer a female to study from Kino Bay, Mexico.

Location of type. Holotype male and allotype female in the Museum California Academy of Science.

Hysteropterum sepulchralis Ball, 1935

(Plates LVII, LVIII, LIX)

Ball, E. D. Some New Issidae With Notes on Others. Bull. Brook. Ent. Soc. XXX (2) p. 37, 1935.

Comparative notes. This species resembles two species rather closely, namely, *H. bufo* Van Duzee and *H. cornutum* var *utahnum* Ball. From *bufo* Doctor Ball points out that it can be distinguished as follows: "Smaller, darker, with less elevated lateral carinae of vertex and the median tablet of the front broader. Dark brown or gray. Length, 3-4 mm." The pronotum of *bufo* is also much longer.

To distinguish this species from the species *cornutum* see the discussion under this heading in the description of that species.

Male genitalia. The anal segment (10th abdominal segment) is similar to that of *cornutum,* although in some specimens it is a trifle shorter and does not reach to the tip of the genital styli. From a flattened dorsal view the anal segment is an elongate lobe, the basal half of which comprises a flat tube, while the apical half is an extension from the ventral margin of this tube in the form of a roundingly pointed flap. The eleventh segment is an inconspicuous ringlike segment which shows only slightly beyond the dorsal posterior margin of the tube and bears a short, slender fingerlike stylus.

The harpagones (genital styli of authors) are visible externally from the ventral view as two triangular plates which meet along the middle. From a flattened lateral view each harpago is roughly pear-shaped. The narrowed anterior end is the point at which it is attached to the body. Across its apex it is broadened to many times its width at base. Its dorsal posterior angle is prolonged cephalad into a curved, handlelike process. At the base of this expanded dorsal corner is located a broad, bluntly rounded external hook whose apex is directed caudad.

The internal genital structure is of the same general pattern as that of *cornutum,* but differs in certain details which can best be seen by comparing the figures on plate LVIII. The paired dorsal

apical lobes of the theca are longer than the aedeagus in *sepulchralis* and their apices are directed caudad instead of dorsad as in *cornutum*. The single ventral apical plate of the theca extends almost to the apex of the aedeagus in this species and the theca does not split at the sides until it reaches a point midway of its length. The well-sclerotized lateral hooks of the aedeagus in this species emerge from the notch in the theca and are somewhat S-shaped as in *cornutum*. However, the shape of the S is different in the two forms; in *sepulchralis* the base of the hook is slender, not deeply bent, thus making the apical loop of the figure the largest, while in *cornutum* the base of the S is the largest part of the figure, due to its broad curvature at this point.

Female genitalia. The anal segment (10th abdominal segment) is a long slender flaplike structure which lies in a vertical plane to the body, so that its apex touches the venter of the eighth abdominal segment and thus almost completely hides the valves of the ovipositor. This segment is longer in this species than in *cornutum*. It is slightly broader through the tubular basal end than across the flaplike apical region. The apex of the flap is roundingly pointed and bears long stout hairs.

The seventh segment has a straight posterior margin as in *cornutum*.

Notes on distribution. The type specimens were collected by Dr. E. D. Ball at Bisbee, Ariz. Paratypes were also taken at Naco and Tombstone, Ariz. All of the type material, according to Doctor Ball, were collected on *Flourensia cernua* (tar-bush).

The writer had available for study a long series from the Mustang mountains in Arizona, one specimen from the Huachuca mountains, Arizona, and a few from each of the following places in New Mexico: Organ, Rodeo, and Santa Fé.

Hysteropterum cornutum var. *cornutum* Melichar, 1906

(Plates LVII, LVIII, LIX)

Melichar, Leopold. Monograph der Issiden (Homoptera). Abh. k. k. Zoöl.-Bot. Ges. Wien, III, pt. 4, 1906.

Comparative notes. Typical specimens of *H. cornutum* are rather easily recognized because of its small size, since its length from apex of head to the tip of tegmina is 3 mm.; and by its pale, uniform creamy-yellow color of body and wings with very few dark spots or markings. Certain specimens, however, may have brown dots in the cells of the tegmina and when they do show this color variation then they approach rather closely the var. *utahnum* Ball.

Structurally *cornutum* is allied to *H. sepulchralis* Ball and *H. bufo* Van Duzee. It is separated from *bufo* by its smaller size, its pale color, by having the single median longitudinal disk of the frons wider or as wide as either lateral disk, the lateral margins of pronotum not elevated against eye and the body not concave across back as in that species.

It is distinguished less easily from *sepulchralis*. The following structural differences can be noted: in *sepulchralis* the anterior margin of the vertex is concave through the middle, so that the length of the vertex at middle is one half the length of the lateral margin, while in *cornutum* this margin sinuately curves cephalad, so that the length of the vertex at middle is not much less than at the sides; the angle above the eye formed by the union of the vertex and frons is acute and prominent in *sepulchralis*, but is rounding and inconspicuous in *cornutum;* and lastly the claval elevations are more prominent in *sepulchralis* than in *cornutum*, where they are usually scarcely noticeable or even lacking entirely.

Male genitalia. The tenth abdominal segment (anal flap) reaches to the tips of the genital styli and in some cases slightly beyond, so that the tip of it is visible beyond the apices of the styli from a ventral view. From the flattened dorsal view the anal segment is an elongate lobe, the basal half of which comprises a flat tube, while the apical half is an extension from the ventral margin of this tube in the form of a roundingly pointed flap. A small, ringlike segment, extending beyond the dorsal margin of the tube, represents the eleventh segment. This segment bears a slender, pointed stylus.

The harpagones (genital styli of authors) are visible externally from the ventral view as two triangular plates which meet along the middle. From this view each harpago appears to be about one-third longer than its width at base. From a flattened lateral view each harpago is roughly pear-shaped. Its narrowed anterior end is the point at which it is attached to the body. Through the apical region it is broadened to over twice its width at base. The posterior dorsal angle is prolonged cephalad into a blunt spatulate lobe. At the base of this expanded dorsal corner is a broad, liplike external hook.

The internal genital structure is a bilaterally symmetrical tubular organ composed of a sclerotized aedeagus surrounded almost completely by the theca. The theca surrounds the aedeagus at base as a tubular sheath for about one third its length, then on each side it splits longitudinally. The dorsal apical two thirds is again

divided so that on each side it extends above the aedeagus as a long slender lobe that reaches to the tip of the aedeagus and terminates in a blunt recurved hook. The ventral part of the split theca extends along the lateral and ventral sides of the aedeagus as a bluntly tapering single flap, which does not quite reach to the apex of the aedeagus. From the notch at the point where the theca splits, a well-sclerotized aedeagal hook emerges, and extends anteriorly and ventralad in the form of a figure S and finally tapers to a finely pointed apex.

Female genitalia. In this species the anal segment is proportionally very long and the valves of the ovipositor appear shorter, so that the result is that the latter are usually almost hidden from a ventral view by the overlapping anal flap (10th abdominal segment). From a flattened dorsal view the flap is parallel-sided and terminates in an evenly rounded apex. The eleventh segment is visible only as a small ringlike segment, only slightly showing beyond the dorsal, posterior margin of the tenth segment. It bears an inconspicuous short pointed stylus.

The eighth and ninth segments are invisible. The seventh segment has an almost straight posterior border.

Notes on distribution. The type specimens were collected at Los Angeles, Cal., in July, by Coquilett. Specimens were at hand for study from the following localities: Lamar, Colo.; Carson City, Nev.; Emery county, Utah; St. George, Utah, all collected by David Fox on *Artemisia tridentata;* Hollister, Idaho, by David Fox on *Artemisia* sp.; and Cajon Pass, California.

Van Duzee (1908) stated that this species was taken by him in abundance in Colorado and Utah.

Hysteropterum cornutum var. *utahnum* Ball, 1935

Ball, E. D. Some New Issidae with Notes on Others. Bull. Brook. Ent. Soc. XXX: 38, 1935.

Comparative notes. This variety is much darker than the typical form; in this respect it resembles more nearly *H. bufo* or *H. sepulchralis.* Doctor Ball describes the color as follows: "Color gray with dark dots and spots throughout, especially marked on the nervures and sometimes forming a double row of dots across the anteapical cells as in *sepulchralis.*"

Notes on distribution and host plants. Doctor Ball collected the type series near the Grand Canyon in August, on *Artemisia cana* Pursh (black sage). The writer had available for study a large

series of several hundred specimens from the Grand Canyon, Santa Rita mountains, Flagstaff, Hereford, Coconimo county, Yavapai county, and Oak Creek canyon, in Arizona; from Las Cruces, Blue Springs, and Datil, in New Mexico; from Dolores and Durango, in Colorado; and from Emery and Cove Fort, Utah.

THE GENUS DICTYONIA Uhler, 1889

Uhler, P. R. New Genera and Species of American Homoptera. Trans. of Md. Acad. of Science, p. 40, 1880.

Comparative notes. This genus resembles *Dictyssa* closely. Yet it differs from that genus by having the tegmina practically as wide as long, exceptionally few and large cells in the wing, the head deeply sunken so that the eyes almost touch the base of the tegmina, and the terga of the abdominal segments so compressed that a conspicuous, elevated and somewhat swollen ridge is formed down the middle of the abdomen.

Like the genus *Dictyssa* it has bispinose hind tibiae and small or rudimentary hind wings.

The genus also superficially resembles the genus *Neaethus* Stal, but it differs from the latter in the reduced number of the cells and their exaggerated proportions on the central area of the tegmina.

Dictyonia obscura Uhler, 1889

(Plates LXVI, LXVII)

Uhler, P. R. New Genera and Species of American Homoptera. Trans. of the Maryland Acad. of Science, p. 40, 1889.

Comparative notes. This genus is monotypic and therefore the distinctive characteristics listed above for the genus are also used in identifying the single species *obscura.* Specifically *Dictyonia obscura* resembles *Dictyssa aereolata* Melichar and *Dictyssa quadravitrea* n. sp. more than other species in the subfamily. Frequently in collections it has been determined as the former. In addition to the generic differences it is easily distinguished from *D. aereolata* by the angular shape and large size of the cells of the tegmina, the widely expanded costal margin and the presence of the broad, cream-colored band down the middle of the frons. It is distinguished externally from *D. quadravitrea* by the extreme broadness of its tegmina, the wide expanded costal margin and again by the cream-colored band on the frons.

Wing venation. In general the wing venation is of the same pattern as that of the genus *Dictyssa.* Vein Sc_1 extends along the costal margin as a distinct vein for two thirds the length of the tegmen.

Veins Sc_2 and R are united for a short distance after leaving the central trunk, then R extends as a single straight vein and Sc_2 as an angled vein toward the apex. Vein M divides near apex into two short branches. Vein Cu_1 runs so close to claval suture that an unusually large hyaline cell occurs between it and vein M; Cu_1 branches into two branches which are not widely separated from the claval suture. Vein Cu_2 extends along the claval suture (Muir). Veins 1st A and 2d A are united at apex to form the Y-vein of the clavus.

Male genitalia. The tenth abdominal segment (anal flap) is an elongate flattened tube with its greatest width at middle, where it is about one half its length, from whence it tapers to a truncate, or sometimes slightly emarginate, apex. The eleventh segment is much reduced, scarcely visible in the anal tube, except for the presence of its elongate stylus, which shows as a slender projection beyond the dorsal margin of the anal flap.

The harpagones (genital styli) are visible externally from the ventral aspect as two adjoining, tapering plates. From a flattened, lateral view (see plate LXVII, drawing 8) each harpago appears as a subquadrangular plate with its dorsal posterior corner projected dorsad as a sharply pointed extension, at the base of which externally is located a flat, recurved hooklike structure.

Like many other genera the aedeagus is asymmetrical. On the left side it appears as a slender, tubular, somewhat pointed structure which is less sclerotized at tip than at base. Attached near its base and extending beyond the theca to a point not quite midway of aedeagus are two parallel, equal-sized heavily sclerotized processes. On the right side the aedeagus bears no sclerotized processes. The tubular membranous theca surrounds the basal third of aedeagus. On the ventral side it is truncate posteriorly, thus allowing the aedeagal hooks to show beyond it. On the dorsal side it extends caudad as a finely tapering projection, whose tip reaches to a point just beyond middle of aedeagus and somewhat caudad to the tips of the aedeagal hooks.

Female genitalia. The anal flap (10th abdominal segment) of the female is similar to that of the male. The external valves of the ovipositor have their greatest width through the middle, at which point they are approximately half as long as wide.

Location of types. Uhler type is lost, according to Mr. Paul Oman, of the National Museum, Washington, D. C.

Notes on distribution. Uhler states that this species had been col-

lected only from central California and around San Francisco. Apparently he described the species from two specimens, or at least only a few. Doctor Ball has sent the writer specimens from Yosemite and Vesalia, Cal. In the Snow Entomological collection at the University of Kansas is a large series collected from Giant Forest, Cal., in June, 1929, and Three Rivers, Cal., in June, 1932, by Dr. R. H. Beamer, and one specimen from Republic, Wash., by John Nottingham, in August, 1931. In the National Museum Collection is a large series, collected by Paul Oman at Three Rivers, Cal., in June, 1935, and a smaller series from Mariposa, Cal.

THE GENUS DICTYONISSUS Uhler, 1876

Uhler, P. R. List of Hemiptera of the Region West of the Mississippi River, Including Those Collected During the Hayden Explorations of 1873. Bull. U. S. Geol. Surv. I, p. 354, 1876.

Comparative notes. The main distinguishing characteristics of the genus are: the collarlike pronotum, which in front is acutely, triangularly narrowed and carried forward almost to the front line of the eyes and is deeply emarginated behind; the long mesonotum, which through middle is as long as combined vertex and pronotum; long, narrow tegmina with costal area not expanded, the veins thick and conspicuous, making a network of large, round aereoles, so that the course of the main longitudinal veins cannot be traced; and the conspicuous, erect hairs on body and tegmina. Tibiae of hind legs with 3 spines. Hind wings reduced to mere scales.

KEY TO THE SPECIES

Ia. Tegmina and body sparsely covered with pitch black, long, stiff hairs; anterior margin of vertex distinctly angulate at middle... ....*D. nigropilosus* n. sp., p. 499

Ib. Tegmina and body sparsely covered with light hairs; anterior margin of vertex evenly rounding ....*D. griphus* Uhler, p. 498

Dictyonissus griphus Uhler, 1876

(Plates LXVI, LXVII)

Comparative notes. For comparison with *D. nigropilosus*, which it closely resembles, see the notes under this heading in the description of that species.

Either species of *Dictyonissus* might possibly be confused with *Misodema reticulata*, especially if one has never seen the latter, since both genera are described as having coarse veins making a network in the tegmen, and the same type of vertex. The two genera are easily separated, however, by the following characteristics: *Dictyonissus* has a pale green body, pale green tegmina with hyaline

areoles and long, erect hairs on the veins of the tegmina and the body; *Misodema* has a fuscous body coloring, and the tegmina are opaque and hairless.

Male genitalia. Anal flap (10th abdominal segment) about twice as long as wide, parallel-margined for two thirds its length, then tapering suddenly at the apex. The eleventh segment and its stylus short and inconspicuous.

The harpagones as viewed externally on the ventral side are two long, slender processes. From a flattened lateral view the dorso-caudal angles of each is found to be prolonged dorsad into a sharply pointed, slightly recurved apex, and at the base of this extension is found an external ventrad-curving, sharply pointed flap.

The aedeagus in this species is partially bilaterally symmetrical. It is tubular in shape and only partially exposed beyond the theca. On the apical three fourths it bears a sclerotized phlange which tapers to a narrow ridge toward the apex and which is serrate along the dorsal margin. The theca appears as a tube covering the aedeagus for approximately one half the length of the latter, then on each side it suddenly projects caudad as a narrow, elongate flap which extends to about the base of the apical third of the aedeagus.

Female genitalia. Anal flap (10th segment) broadest through middle, suddenly tapering to a roundingly pointed apex. The eleventh segment scarcely visible, its stylus moderately long. The external valves of the ovipositor broadest through middle third.

Notes on distribution. Uhler states that it inhabits Texas. The type specimen was collected at Waco by Belfrage. In 1929 a large series was collected in Kerr county, Karnes county, and Menard county in Texas by R. H. Beamer. Several specimens were taken in 1932 at Monterey, Nuevoleon, Mexico, by L. D. Tuthill.

Dictyonissus nigropilosus n. sp.

(Plates LXVI, LXVII)

ORIGINAL DESCRIPTION

Size. Length of body from apex of head to tip of tegmen, 3.3 mm. to 3.8 mm. Length of tegmen, 2.7 mm. to 3.2 mm.; width of tegmen, 1.6 mm. Much smaller than *griphus.*

Color. Same general light green to testaceous color as in *D. griphus,* but with pitch black hairs over body and tegmina instead of light ones. Body uniform light green or greenish-tan. Anterior margin of vertex darkish. A bronze caste over disk of mesonotum. Eyes brown to black. Frons without the black dots found in *griphus,*

but base of black hairs also sometimes black. Venter of body green. Legs also green except for a bronze caste on tarsus, and tip of tarsal claws black. Tegmina greenish or greenish-tan, translucent, and very thick green veins.

Structural details. Vertex greatly protruding beyond eyes, its total width equal to its total length, the anterior margin distinctly angulately produced through middle, the posterior margin deeply roundingly emarginate, lateral angles parallel. Frons greatly elongate, narrowed at base, its lateral margins outwardly curving so that its greatest width is at base of apical third; a distinct median carina present for about two thirds its length, the entire disk together with the carina at base considerably elevated, leaving a shallow groove just mesad of each lateral margin, which is also elevated. Clypeus short,.about two thirds the length of one lateral margin of the frons. Femora of legs slightly sulcate, tibiae greatly so. Pronotum collarlike as for the genus, but each lateral arm more rounded and elevated into a knob than in *D. griphus*. Mesonotum conspicuously humped at anterior end, two distinct lateral carinae present and a median longitudinal groove plainly visible. Costal margin of tegmen only slightly rounding, costal cell area broad, more broadly extended at anterior end than in *griphus;* longitudinal veins only distinguishable for a short distance at base, after which they are lost in the reticulation.

Male genitalia. Anal flap (10th abdominal segment) tubular at base for half the length, from which point the ventral margin extends posteriorly into a bilobed, somewhat pointed flap. Beyond the dorsal margin the ringlike eleventh segment is only slightly visible and bears a long fingerlike stylus.

Each harpago from a flattened lateral view is roughly bootshaped, broadest at its extreme apical end, where the dorsal corner extends into a sharply pointed triangular projection. A flat, caudad-bending external hook is located midway of this projection.

The aedeagus is a semisclerotized tubular process which extends about halfway beyond the theca. On the right side it bears a narrow phlange which is saw-toothed on the dorsal margin. Just posterior to the end of the phlange is a recurved, well sclerotized hook. On the left side a similar phlange with a serrate dorsal edge is also present and another well-sclerotized hook, the apex of which only, shows beyond the edge of the theca as a sharply pointed bladelike process. The theca envelopes the aedeagus for half its length and has its caudal margin on both sides deeply notched through middle.

Comparative notes. There are only two species in the genus. They resemble each other closely in color, size and general features. They are easily distinguished by the presence of pitch-black hairs on body and tegmina in *nigropilosus,* together with the angulate vertex and the very narrow frons without any black markings. *D. griphus* has golden or light hairs, the anterior margin of vertex distinctly rounding and more produced beyond eyes and a broader frons with a row of black spots indicated in each lateral disk. *D. griphus* usually is a trifle larger than *nigropilosus,* its measurements being 3.5 mm. to 3.8 mm. from apex of head to tip of tegmen.

Location of types. Described from 3 males and 1 female. Holotype male and allotype female and two male paratypes taken at George West, Texas, July 1, 1936, collected by R. H. Beamer.

These types are in the Snow Entomological Collection, University of Kansas.

THE GENUS NEAETHUS Stal

Stal, Carolus Rio Jan. Hemip II, p. 67, 1862

Description of the genus. This genus is similar to *Dictyssa* and *Dictyonia.* They are small insects with hemispherical, translucent or semitransparent tegmina and thick veins. The apical margin of each tegmen is strongly rounded and the costal margin expanded. Vertex is short through middle, much wider than long, not produced greatly beyond eyes. Pronotum extremely narrow at sides, where it is shortened to almost a point; its anterior margin deeply emarginate into region of the vertex; its posterior margin shallowly concave. Mesonotum is triangular with or without a median carinae and an arcuated groove just back of anterior margin. Frons is held vertically to body, is usually more or less parallel-margined, truncate posteriorly, and deeply emarginate anteriorly for the insertion of the postclypeus. Clypeus is triangular, not keeled on margins. Tegmina held vertically and lying adpressed to body, translucent or semiopaque, always with heavy, conspicuous veins and many cross veins forming small angular cells. Wing venation, based on Muir, Tillyard and Snodgrass, is similar to *Dictyssa,* showing the following general characteristics: vein Sc divided, Sc_1 (equal costal vein of Metcalf) running along costal border for about one third the length of the tegmen, veins Sc_2 and R united at base and their apices sometimes completely lost in reticulation, in other cases each branches again near tip; vein M always two branched, the branches of each of these either apically not traceable in the reticulation or frequently branched several times, making a 4-, 5- or even 7-branched vein; vein

Cu_1 divided into two branches, Cu_{1a} and Cu_{1b}; vein Cu_2 forming the claval suture; 1st A and 2d A present. Hind wings are of three types; as long as the tegmina, very much abbreviated, but with a longitudinal fold indicated, or reduced to a mere scale. Two spines are present on the hind tibiae.

HISTORY OF THE GENUS

The genus was erected by Stal in 1862. Previously he had described *vitripennis* (Of. Vet. Akad. Forh. XI, p. 247) in 1854 as a *Hysteropterum*. This species is now regarded as the haplotype of the genus *Neaethus*. In 1906 Melichar described four other species, namely, *fenestratus, grossus, nigronervosus* and *maculatus*. In 1921 Van Duzee added *fragosus* to the group. In the present paper seven new species are being added to the list of North American species, making a total of thirteen.

On the whole the species in this genus are not easily recognized by external characteristics. The most closely allied species groups perhaps are the *nigronervosus-fenestratus* group and the *diversus-uniformus-curvaminus* group. The first one has widely different genitalia. The latter group have somewhat similar genitalia. The general reader may have difficulty in identifying all of these species by external characteristics. Close study of the genitalia show differences that are constant and it is upon these differences, since in some instances long series of slides were made from several localities, that the species have been erected. The home of the genus seems to be California and the Southwest, where many of them have been taken from oaks. Mr. Paul Oman, of the National Museum, and Dr. R. H. Beamer have stated that they have taken them from different varieties of oak trees even in the same mountain range. Apparently this genus is one of the highly variable groups which has split up into many species corresponding to different species or varieties of the host-plant group.

KEY TO SPECIES

1. Hind wings as long as or only slightly shorter than front wings............ 2
   Hind wings rudimentary, less than one fourth length of front wings......... 4

2. (1) Tegmina translucent and held vertically against body; pronotum greatly narrower than head..................................*perlucidus* n. sp., p. 503
   Tegmina more or less opaque and held somewhat horizontally; pronotum only slightly narrower than head.. 3

3. (2) Larger insects, 5 to 6 mm. long; lateral margins of vertex longer than width across eye; narrow costal cell.....................*fragosus* Van Duzee, p. 506
   Smaller insects under 4.6 mm.; vertex concave, short, one lateral margin equal to or less than width across eye; broad costal cell....*grossus* Mel., p. 507

4. (1) Tegmina translucent, with a black band extending from clavus to costal margin and a brown spot at apex of clavus; pronotum deeply notched behind eye .... *maculatus* Mel., p. 510

Tegmina without such bands or spots; pronotum not so deeply notched..... 5

5. (4) Translucent tegmina with light veins.................................. 6

Tegmina more opaque, with either very thick, light or darker to black, thin veins 7

6. (5) Lateral arm of pronotum back of eye longer, anterior margin of pronotum notched; postclypeus length equal to one lateral margin of frons; costal cell wide and distinctly reflexed; vein Cu branching considerably anterior to middle .... *vitripennis* Stal, p. 512

Lateral part of pronotum short, not knobbed or deeply notched behind eye; postclypeus shorter; costal cell narrower and not reflexed; vein Cu branched at about middle........................ *sinchamatus* n. sp., p. 515

7. (5) Larger insects, usually 4.4 mm. or over; vein Sc_1 straight and long, extending for at least one third length of wing; hind wings rudimentary but folded once longitudinally 8

Smaller insects, under 4.4 mm. (occasionally females larger): vein Sc_1 distinctly curved and short, not extending one third of wing length; hind wings reduced to mere scales with no longitudinal folds........ 9

8. (7) Head produced beyond anterior margin of eye, frons narrow, one lateral margin greater than its basal margin; anal flap of male two-pronged *similis* n. sp., p. 517

Head scarcely produced beyond eye; frons broad, length and width about equal, anal flap of male rounded.................. *jacintiensus* n. sp., p. 519

9 (7) Veins either all dark or at least cross veins dark or darkish; vein Cu_1 not uniting before apex or lost in reticulation.. 10

Veins light throughout; vein Cu_1 uniting in some way before apex.......... 11

10 (9) Veins of female usually all black (longitudinal veins of male and some females lighter); vein Sc_1 greatly arched, short, not more than about one fourth length of tegmen; apical cells long and parallel......*nigronervosus* Mel., p. 522

Longitudinal veins light; vein Sc_1 short, but straight; a cluster of small cells at apex of corium .. ..*fenestratus* Mel., p. 525

11. (9) Veins thin, costal cell wide, vein Sc_1 distinctly inwardly arched so that costal cells are wider than long, elongate cells at apex as in *nigronervosus*, *curvaminus* n. sp., p. 528

Veins thick, costal cell narrower, with the small cells in this area either longer than wide or square; an irregular reticulation of small cells at apex...... 12

12 (11) More cross veins in costal cell area, numbering usually 7 or 8; clypeus longer, its length equal to one lateral margin of frons....*uniformus* n. sp., p. 530

Fewer cross veins in costal cell area, numbering only 4 or 5; clypeus shorter, its length only equal to basal or posterior margin of frons..*diversus* n sp., p. 532

Neaethus perlucidus n. sp.

(Plates LX, LXI, LXII, LXIII)

ORIGINAL DESCRIPTION

Size. Length of body to tip of tegmen, 4.4 mm. to 4.6 mm. Length of tegmen, 3.6 mm.; width of tegmen, 2.6 mm. This is a medium-sized species for this genus.

Color. Uniform straw-yellow, with few darker markings. Body uniformly a darker or straw-yellow, except margins of all segments and sclerites light cream, also a faint cream line down middle of

vertex, pronotum and mesonotum and middle abdominal segments from below with a greenish caste. Tegmina translucent straw-yellow or light amber; veins same color except a few dark cross veins on inner border of clavus and again at apex. Hind wings pale yellow, translucent. Eyes brownish. Clavola (flagellum) of antenna brownish-black. Legs all yellow except for black tips of the spines.

Structural details. Vertex subrectangular, slightly concave, much shorter through middle than at sides, its width at the anterior margin twice the length of one lateral margin, the lateral margins outwardly convex. Greatest width of eyes half the width of vertex. Frons depressed lengthwise through middle, lateral margins elevated, and slightly outwardly convex so that greatest width of frons is through its anterior fourth, median carina present but disappearing before reaching clypeus. Postclypeus with posterior margin angularly produced into frons for a distance equal to about one fifth the length of the latter.

Pronotum much narrower than head, its anterior margin roundingly produced for greater distance into vertex than in *vitripennis*, its posterior margin shallowly emarginate; its extreme lateral part behind eye greatly abbreviated to about one sixth its length through middle and not deeply notched as in *maculatus*. Mesonotum with only a very faint median carina present, a deep transverse groove following anterior margin, but stopping at either side before reaching lateral margin, where each lateral corner is bullate. Tegmina approximately one third longer than wide, their greatest width approximately through middle, hemispherical in outline, due to both the apical and costal borders being evenly rounding; longitudinal and cross veins heavy, and forming large, irregular, angulate cells; costal cell area very broadly expanded; vein Sc_1 running as a stiff, straight vein from base to costal margin, making the cells in middle of the expanded border much larger than either the anterior or posterior ones; vein M only four-branched; vein Cu branched at about middle and veins Cu_{1a} and Cu_{1b} united before apex again and the combined vein shortly uniting with vein M_{3+4}. Hind wings as long as tegmina.

Male genitalia. Anal flap (10th abdominal segment) in flattened view approximately twice as long as wide with its lateral margins subparallel and its posterior margin roundingly emarginate. Eleventh segment ringlike, only slightly showing beyond rim of tenth segment and bearing the usual fingerlike stylus.

The harpago (genital stylus) from a flattened lateral view ap-

pearing subquadrangular, broadest at its middle, due to slight bulging at this point of the ventral margin, the dorsal posterior corner extended dorsad into a sharply pointed process, at base of which is a ventrad-curved small external hook.

The aedeagus as viewed from the left side is a partially sclerotized tube bearing three sclerotized pointed flaps located as follows: a short curved one attached approximately at apex on anterior fourth and which is gently curved dorsad, a long, flat, sharply pointed one attached somewhat near base of aedeagus so that only its distal half shows beyond the theca, and the third attached near the middle and extending to near the apical curve of the aedeagus. The apical ninth of the aedeagus is recurved and is bulbous at base, then narrows to a sharply pointed apex. On the right side the aedeagus shows only one sclerotized hook or flap whose apex reaches approximately to base of apical third. The semisclerotized theca covers the aedeagus at base. On the left side it appears as a bluntly pointed sheathlike flap. On the right side it extends about one half the length of the aedeagus. Posteriorly it is truncate on the dorsal side and on the ventral side extends posteriorly as an elongate, slightly dorsad-curving hook.

Comparative notes. This species has probably always been identified as *N. vitripennis* Stal, because of its close resemblance in size, coloring and translucent tegmina. For the same reason it would be confused with *sinehamatus* n. sp. It is readily separated from these two species by the presence of long hind wings. For further details of comparison, see the notes under this heading in the descriptions of these species.

The presence of long hind wings places it near *fragosus* Van Duzee and *grossus* Melichar. It is easily distinguished from these two by the transparency of the tegmina and the lack of maculation or dark veins which are found on them. Other characters which distinguish these three species are as follows: *perlucidus* has a much narrower thorax than either of the other two; *perlucidus* and *fragosus* have the pronotum deeply produced anteriorly into the vertex, while *grossus* is only shallowly produced; in *perlucidus* the expanded costal border is very broad, and vein Sc_1 is very straight, thus making the cells in the middle of the costal area larger than at either end; in *grossus* Sc_1 curves outwardly, following the costal border, and thus the transverse cells are practically the same width; in *fragosus* the costal area is expanded only half as much as in *grossus* and *perlucidus; grossus* is conspicuously gibbous between

Sc_1 and R just in front of middle, which condition is only faintly indicated in *fragosus*, entirely lacking in *perlucidus;* finally the position in which the tegmina are held against the body varies in the three, in *fragosus* being held more horizontal, in *perlucidus* almost vertical and in *grossus* halfway between the other two.

Notes on distribution. Collected at Three Rivers, Cal., on July 8, 1932.

Location of types. Holotype male, collected at Three Rivers, Cal., July 8, 1932, and three paratype males same place, by Dr. R. H. Beamer. These types are in the Snow Entomological Collection at the University of Kansas.

Neaethus fragosus Van Duzee, 1921

(Plates LX, LXI, LXII, LXIII)

Van Duzee, E. P. Characters of Some New Species of North American Hemipterous Insects with one New Genus. Proc. Cal. Acad. of Sci. XI (10) pp. 111-134, 1921.

Comparative notes. One of the largest species in the genus, measuring 4.5 to 6 mm. from apex of head to tip of tegmen. Readily distinguished by the semiopaque, long and narrow tegmina with a narrow, expanded costal border; vein M 5-branched; veins Cu_{1a} and Cu_{1b} united before apex; and the presence of hind wings which are nearly as long as the tegmina.

Van Duzee gives a description of the coloration as follows: "Yellowish or greenish testaceous, in male usually becoming brownish on vertex and face, with a paler area on apex of front; veins of elytra sometimes distinctly infuscated, especially in the male."

This species closely resembles *N. grossus* Melichar. It also is placed near *N. perlucidus* n. sp., because of the long hind wings. For detailed comparison of these three species see the notes under this heading in the description of *N. perlucidus.*

Male genitalia. Anal flap (10th abdominal segment) comparatively broad, its lateral margins outwardly curving to about their middle, then converging to a narrowed truncate apex, the flaplike extension from the basal margin not quite half the length of the entire segment. Eleventh abdominal segment ringlike with a short fingerlike stylus.

Harpago as viewed from a flattened lateral view roughly subquadrangular, its ventral margin rounding outwardly, its dorsal margin shallowly convex through middle, but at apical third extending dorsad a short distance, then making an obtuse angle and running posteriorly. The extreme dorsoposterior corner extended posteriorly as a short, blunt projection, of which both the ventral

and posterior corners are finely pointed and somewhat recurved. At the base of this posterior projection is a slender, recurved external hook. The aedeagus is somewhat more complex in this species than in others of the genus. Its basal half is covered by the theca. The apical portion that is visible beyond the theca is curved into a semicircle, is somewhat membranous so as to appear slightly wrinkled on the dorsal side and tapers to a broadly rounded apex. From a left view two well-sclerotized processes are visible; one a broad, flat projection attached at middle of aedeagus and extending caudad to about base of apical sixth, where it ends in a finely pointed apex; the other a stout, hornlike process attached nearer to base of aedeagus and only partially visible beyond the posterior apex of the theca. This hook is broad at base, but gently tapers to a pointed apex. It runs parallel with the aedeagus for a short distance, then, just after its emergence from the theca, it abruptly bends dorsad toward the aedeagus and partially overlaps the rim of the latter on the right side. This ventral hook is visible from either side of the aedeagus. On the right side there is present a similar dorsal flat projection as is seen on the left. The theca is practically the same on either side. It appears basally over the aedeagus as a membranous tube. At its dorsoposterior corner it extends posteriorly as a rounded elongate flap which ends in a small short dorsal spine.

Notes on distribution. The type locality is the summit of Mt. Wilson, Pasadena, Cal. A series of twenty-five specimens have been collected by Dr. R. H. Beamer from the following places in California: Anza, Idyllwild, Three Rivers, and San Jacinto mountains, in July and August.

Location of types. Museum of the California Academy of Science.

Neaethus grossus Melichar, 1906

(Plates LX, LXI, LXII, LXV)

Melichar, Leopold. Monograph der Issiden (Homoptera). Abh. k. k. Zoöl.-Bot. Ges. Wien, III, pt. 4, 1906.

Size. Length of body to tip of tegmen, 4 mm. to 4.6 mm. Length of tegmen, 3.37 mm. to 3.8 mm.; width of tegmen, 2.08 mm. This is one of the median-sized species in the genus.

Color. General color yellow, mottled with blackish-brown. Eyes yellow, spotted with red or all reddish-brown. Vertex dark tan with a cream-colored carina down middle, lateral margins also cream, enlarging to a spot at posterior corner. Pronotum tan with a cream-colored median carina and a cream spot at each corner behind eyes. Mesonotum brown except for two yellow spots on each side, one of

which lies anteriorly against the anterior margin and the other in line with it but on the posterior border, apex also cream. Frons reddish-brown, thin outer margins dark brown with a narrow white band bordering them on the inside and a large spot in center which is cream. Postclypeus reddish-brown, anteclypeus yellow, a dark longitudinal abbreviated stripe on each side running across both sclerites. Venter of body light yellow through middle, becoming darker at the sides and fifth and sixth abdominal segments washed in brown through middle and at extreme sides. Ventral ovipositor valves red-brown with their inner margins forming a dark-brown line. Legs brownish through middle, lighter at apices of segments, claws on tarsus black-tipped. Tegmina ground color semiopaque creamish-yellow, longitudinal veins yellow, cross veins varying from light brown to dark brown, usually the dark brown ones forming an irregularly spotted band, starting on clavus in line with apex of mesonotum and extending vertically across corium to costal border or sometimes forming more of an elongate vertical spot rather than a band, many dark veinlets again indicated in irregular patches in posterior half.

Structural details. Vertex subrectangular, broad, being at least four times wider across anterior margin than at middle, lateral margins diverging posteriorly, each margin twice as long as length through middle, anterior margin almost straight, only slightly produced anteriorly, not much greater than anterior margin of eye. Frons depressed through middle, its lateral margins distinctly elevated and diverging anteriorly so that greatest width is through its anterior fifth, a median carina distinctly indicated for two thirds its length. Pronotum scarcely narrower than head, roundingly and comparatively shallowly produced anteriorly and narrower at this point than in *maculatus*. Mesonotum one third wider than long, each lateral fourth slightly bullate, a deep crescent-shaped groove following the anterior margin, but stopping just mesad of each lateral bulla; a very faint median carina present. Tegmina approximately one third longer than wide, their greatest width in line with apical sixth of clavus, distinctly bullate between veins Sc_1 and R at basal third of wing, costal cell area widely expanded. Longitudinal veins more elevated than cross veins, but of less diameter than many of the latter, the cross veins forming an irregular network of small veinlets. Vein Sc_1 rather gently curving, following outline of costal border, so that the cells in the expanded costal region are practically the same size and the transverse veins in this

region usually forked at end. Vein M_{3+4} often 3-branched, making a 5-branched media; all the branches of M and Cu_1 posteriorly arched and running close together, but not united before apex as in some species. Hind wings as long as tegmina.

Male genitalia. Anal flap (10th abdominal segment) in flattened view not quite twice as long as wide; its lateral margins subparallel and its posterior margin roundingly produced. Eleventh segment ringlike, only slightly visible beyond rim of 10th segment and bearing the usual fingerlike stylus.

The harpago (genital stylus) from a flattened lateral view appearing as a subquadrangular flat plate about twice as long as wide, its ventral margin outwardly rounding, the dorsal margin slightly convex through middle and its posterior angle prolonged cephalad as a short pointed hooklike process, another triangular external hook attached at base of dorsal process and with its apex directed ventrad.

The aedeagus, as viewed from the left side, is a partially sclerotized tube bearing two sclerotized external processes, the more distal one attached to middle and extending caudad as an elongate narrow flap, which narrows to a bluntly rounding point reaching to about the base of the distal eighth of the aedeagus; the second process at base covered by the theca, but attached somewhat near the apex of basal fourth of aedeagus and showing beyond the theca as a well-sclerotized hook, which is broad at base, gently narrows to a slenderly pointed apex and reaches not quite to middle of aedeagus. On the right side the aedeagus shows only one flaplike extension which rises obliquely from the sides of the aedeagus, beginning at base of apical third and whose pointed apex reaches to base of apical sixth of aedeagus. The theca covers the base of aedeagus as a tube, extending on the left side about one third of the length of aedeagus, and ends posteriorly with a truncate margin. On the right side the dorsal margin of the theca is extended caudad as a sinuately margined flap which at its apex suddenly bends ventrad in the form of a pointed hook.

Comparative notes. This species more closely resembles *N. fragosus* Melichar than any other one. It is separated easily from the latter by having a distinct bulla at the base of each tegmen and by the more widely expanded costal border. For more details of comparison see notes under this heading in the description of *N. perlucidus.*

Notes on distribution. Type locality is given as Los Angeles, Cal.

In the Snow Entomological Collection are specimens from the Santa Rita mountains, Ariz., and the following places in California: Mint Canyon, Monrovia Canyon and Lockwood.

Location of type. Types are in the National Museum in Washington, D. C.

var. *pallida* Melichar

Melichar states that dark speckling or bands on the tegmina are sometimes lacking so that they appear pale yellowish. He calls this type variety *pallida*. Out of twenty-seven specimens studied the writer found eight which would fall under this classification.

Neaethus maculatus Melichar, 1906

(Plates LX, LXI, LXII, LXV)

Melichar, Leopold. Monograph der Issiden (Homoptera). Abh. k. k. Zoöl.-Bot. Ges. Wien, III, pt. 4, 1906.

Size. Length of body from apex of head to tip of tegmen is 4 mm. to 4.4 mm. Length of tegmen, 3.6 mm. to 4 mm.; greatest width of tegmen, 2.132 to 2.532 mm.

Color. General color light tan with transparent tegmina crossed by two oblique brownish-fuscous bands. Eyes light brown, banded or spotted in red. Vertex usually uniform yellow, sometimes spotted with light brown, especially females. Pronotum yellow tan with dark, paired, round pits in middle, sometimes numerous dark dots at sides. Frons and clypeus light yellow, a dark brown longitudinal streak on each side just laterad of the median carina and another irregular dark longitudinal streak more laterad to this, followed by a border of brown dots, then a longitudinal pale band, finally bordered by the very thin, dark lateral edge. Clypeus usually with a light median carina and sides washed in brown or with numerous oblique brown stripes on each side. Venter of body either uniform light yellow or frequently washed in fuscous, especially across bases of segments or at sides along the margins. Tegmina translucent greyish-tan with conspicuous dark veins, a prominent dark-brown oblique band before middle, beginning on base of clavus and extending slightly posteriorly across corium to a point on costal margin where vein Sc_1 ends; another interrupted band beginning at apex of clavus extending half across corium where it is lacking for width of one cell, then starts again somewhat more posteriorly and ends on apical margin. The latter part of this band or spot is frequently entirely lacking. Legs uniform yellow or sometimes washed in fuscous or with longitudinal carinae fuscous; claws black tipped.

Structural details. Vertex not much produced beyond eyes, concave through middle, anterior margin straight, at this margin 4½ times wider than length along middorsal line, lateral margins converging slightly anteriorly. Pronotum much narrower than head, anterior margin broadly rounding, deeply notched behind eye and greatly overlapping vertex through middle; two round paired pits in center of disk. Mesonotum one third longer than wide, three carinae present, each lateral fourth bullate, a deep crescent-shaped groove following the anterior margin but stopping just mesad of each lateral bulla. Frons with basal or posterior margin straight, a median carina present for practically the entire length, lateral margins distinctly parallel and greatly elevated. Clypeus with a median carina present and deeply inserted into frons. Tegmina roughly twice as wide as long, superficially wedge-shaped with greatest width just anterior to apex of clavus; veins distinct, very few cross veins, so that the cells of wing are angular and easily counted; vein Sc_1 a wide distance from costal margin, so that this species has an especially widely expanded costal area, the transverse veins in the region numbering 8 or 9. Venation characteristic for the genus with veins Sc_2, R, M_{1+2} and M_{3+4} each branching once, making a 4-branched media, Cu_{1a} and Cu_{1b} fused before apex and the single vein following apical border until it runs into vein M_{3-4}, thus setting off a narrow phlange. Hind wings very short or rudimentary, folded once longitudinally. (Melichar stated that they are lacking.)

Male genitalia. Anal flap (10th abdominal segment) more elongate than in many species, its length being 2½ times its greatest width, which is across the flap part of the segment just posterior to the rim of the segment, due to the lateral margins bulging slightly at this point; the apical margin of the flap deeply, roundingly notched. Eleventh segment with an elongate fingerlike stylus as in drawing.

The harpago, as viewed from a flattened position on a microscope slide, is peculiar in shape in that its length is not much greater than its width across its apex where its posterior dorsal corner is broadly extended dorsad. At this dorsal posterior corner is located a small external, sharply pointed hook.

The aedeagal structure has a more complex theca than in most species. The aedeagus itself is extremely slender, showing only at apical end beyond the theca, where it appears as a slender, goose-necked structure which bends out from the theca and then back in almost a complete circle, thus bringing the extreme apex under the

theca again. On the left side two sclerotized processes show, one a long, flat, bladelike structure attached approximately at middle and ending just cephalad of apex of thecal flap, the other a short, sharply pointed hook which is only barely visible beyond posterior margin of theca. On the right side only the tip end of an aedeagal hook shows beyond the theca. The theca is a long semisclerotized tube extending half way over the aedeagus. On the left side it ends truncately at the middle, except at the dorsal corner, where it is extended caudad for some distance as a flap whose edges partially fold together. On the right side the theca continues caudad as a broad lobe which ends truncately at base of apical fourth of aedeagus.

Comparative notes. *N. maculatus* is readily distinguished from all other species by the color of the tegmen, which is translucent, with one anterior oblique dark band and a partial posterior one, and the color of the frons, which has two lateral dark longitudinal streaks on each side of the median carina.

It more closely resembles *N. perlucidus* n. sp. and *N. vitripennis* Stal. From the former it differs by the presence of rudimentary hind wings instead of long ones, by having a deep notch in pronotum just behind eye, by a more wedge-shaped tegmen than a hemispherical one as in *perlucidus* and by having the combined distal part of Cu_{1a} and Cu_{1b} long, following the apical margin and thus setting off a narrow phlange.

For comparison with *N. vitripennis* Stal, see notes under this heading in the description of that species.

Notes on distribution. Type locality is given as St. Cruz and Sonoma, California. A few specimens have been collected by R. H. Beamer in July, from the following places in California: Maria county, Leona Heights, Niles, Upper Lake, Mt. Diablo, and Boulder Creek.

Location of types. In the United States National Museum at Washington, D. C.

Neaethus vitripennis Stal, 1854

(Plates LX, LXI, LXII, LXIII)

Stal, Carolus. Of. Vet. Aked. Forh., XI, p. 247. (Hysteropterum.)

Size. Length from apex of head to tip of tegmen is 4.4 mm. to 5.2 mm. Length of tegmen, 4 mm. to 4.4 mm.; width of tegmen, 2.08 mm. to 4 mm.

Color. Entirely golden yellow. Tegmina transparent and all yellow. Eyes brown. Claws on tarsus black-tipped.

Structural details. Vertex broad and extremely short through

middle where it is slightly more than one fifth of the anterior margin, moderately produced beyond eyes, anterior margin slightly rounded. Frons with lateral margins subparallel, outwardly rounding somewhat so that greatest width is across apical fifth, lateral margins greatly elevated, median carina present down entire length. Postclypeus comparatively much longer than in *N. maculatus* or *N. perlucidus*. In this species its greatest length is equal to one lateral margin of the frons. Pronotum much narrower than the head, deeply notched behind eyes as in *N. maculatus*, but with a thicker lateral arm than in *perlucidus*, its anterior margin roundingly produced as an even hemisphere, its posterior margin shallowly convex. Mesonotum through middle twice longer than pronotum, a median longitudinal carina indicated and a short, lateral one, on each side just mesad of each lateral bulla; a deep groove indicated just posterior to the anterior margin. Tegmina less semicircular in outline with the costal margin more parallel to the claval margin than in *perlucidus;* cells of wing large, angular and a good many less cross veins than in other species; vein Sc_1 straight and widely separated from the costal margin making a widely expanded costal area, traversed by 8 to 9 veinlets and with the cells thus set off wider through middle than at either end; vein M four-branched; vein Cu branching considerably before middle and veins Cu_{1a} and Cu_{1b} thus separated by a longer cell than in *maculatus* and others, but united at apex and running as a combined vein just inside of apical margin for a considerable distance before joining vein M_4 and with the latter vein setting off a narrow phlange for half the width of the apical margin. Hind wings rudimentary, folded once longitudinally.

Male genitalia. Anal flap (10th abdominal segment) a large, broad, flaplike structure, tubular at base and with its ventral, posterior margin extended posteriorly, but to much less degree than in *maculatus*, as a flaplike extension which is deeply and broadly emarginate, so that it gives the structure a two-pronged effect. Eleventh segment a small but distinct tube with a conspicuous fingerlike stylus.

Each harpago, as viewed from a flattened view, is a subquadrangular plate with its posterior dorsal corner extended dorsad into a triangular, sharply pointed projection, and bears a small, ventrad-pointing external hook located half way on the dorsal extension.

The aedeagal structure is complex. The aedeagus proper is an elongate, tubular, well-sclerotized structure, which extends beyond

the theca in goose-necked fashion and finally tapers to a sharply pointed apex which is bent back toward itself. From a left view it shows four well-sclerotized hooks located as follows: one short, sharply pointed one, located approximately at base of apical fourth; another located approximately at middle of aedeagus and which makes a semicircular curve ventrad after emerging from the thecal rim; a third and very small, sharply pointed lateral hook, located just posterior to middle; and a fourth long, stiletto-type flap located just above the lateral posterior hook. On the right side no new hooks show, only the apices of the dorsal and ventral left hooks showing beyond the thecal margin. The theca on the left side completely covers the aedeagus only at base, then along dorsal side only extends caudad as a broad lobe to base of apical third of aedeagus, where it is notched and forms two pointed prongs. On the right side the theca covers the aedeagus all but its apical third or fourth.

Comparative notes. This species closely resembles the following species: *N. maculatus* Melichar and *N. perlucidus* n. sp., in size, translucency, in texture, the large angulate cells and the widely expanded costal area. These three species are separated from each other in the following ways: pronotum deeply notched behind eyes in *vitripennis* and *maculatus*, but not so deeply in *perlucidus;* tegmina held vertically to body in *vitripennis* and *perlucidus*, but much more porrect in *maculatus;* hind wings long in *perlucidus*, rudimentary in other two; clypeus much longer proportionally to frons in *vitripennis* than in *perlucidus* or *maculatus;* costal margin and claval margin subparallel in *vitripennis* and *maculatus*, but distinctly outwardly rounding in *perlucidus*. Veins Cu_{1a} and Cu_{1b} united for only a short distance at apex in *perlucidus*, with no narrowed phlange set off along posterior border, while in *vitripennis* they are combined for a longer distance and together with vein M_4 sets off a phlange for about one half the width of the apical margin and in *maculatus* for about one third the width of the tegmen.

Vitripennis Stal may very easily be confused with *sinehamatus*, which in many respects it more closely resembles than any of the above. For comparison, see the notes under this heading in the description of that species.

It also closely resembles superficially *N. similis* n. sp. For comparison of this species see notes under this heading in the description of that species.

Notes on distribution. In the National Museum at Washington, D. C., are examples from Tamalpais and San Francisco, Cal. The type locality is San Francisco.

Neaethus sinehamatus n. sp.

(Plates LX, LXI, LXII, LXIII)

ORIGINAL DESCRIPTION

Size. Length from tip of head to apex of tegmen, 4.6 mm. to 4.8 mm. Length of each tegmen, 3.9 mm. to 4 mm.; width of each tegmen, 2.4 mm.

Color. Like *vitripennis* and *perlucidus* in being a uniform pale golden yellow. Eyes grayish-brown. Veins at apex of clavus tinted dark brown. Clavola of antenna blackish-brown. Tarsal segments reddish-brown. Tip of claws on legs black.

Structural details. Shape of head and pronotum similar to *perlucidus* n. sp. Vertex twice wider than length at sides, its anterior margin slightly angulate at middle, not produced beyond anterior margin of eye, lateral margins parallel. Greatest width of eyes half width of vertex. Frons and clypeus equal in length. Lateral margins of frons elevated and diverging from posterior margin so that greatest width is at base of apical fifth, a distinct median carina present and disk concave on either side. Pronotum much narrower than head, its anterior margin roundingly produced into vertex, but not notched behind eyes, the lateral arm set off at this point much shorter in length than in some species. Mesonotum one third wider than length at middle, only a faint median carina indicated, each lateral third bullate, a deep crescent-shaped groove following and very close to posterior line of pronotum. Tegmen not semihemispherical or parallel margined, but with greatest width in line with apex of clavus. Veins of tegmen heavy, cross veins few and forming large angulate cells. Vein Sc_1 much closer to margin than in related species, thus setting off a much narrower expanded costal cell than in other species which is not recurved and traversed by only six or seven cross veins; vein M only four-branched; vein Cu_1 branching just before middle of tegmen, then veins Cu_{1a} and Cu_{1b} again uniting at apex and extending as a short ventrad-curving vein to meet M_4. Hind wings rudimentary, folded once longitudinally.

Male genitalia. Anal flap (10th abdominal segment) much shorter than in *vitripennis* Stal. Its expanded ventral apical margin not any longer than the tubular basal part, the extreme apex very shallowly emarginate. Eleventh segment only slightly visible and bearing a short stylus.

Each harpago, as viewed from a flattened view, is a subquadrangular plate with its posterior or distal end extended dorsad as a projection which is slightly bulbous at base where it bears an ex-

ternal, ventrad-directed pointed hook and then ends in a spatulate lobe.

The aedeagus on the left side appears as a semimembranous tubular organ bearing several well-sclerotized processes located as follows: one attached at extreme base, gently curved in a semicircle, and ending in a point just beyond middle; a second long, flat process attached at middle is parallel-margined for three fourths of its own length and has its apical bent end, ending in a fine point not far distant from apex of aedeagus; a third very short spine attached just anterior to middle. On the right side no additional hooks of the aedeagus are visible. The theca is unusual in that it covers only the extreme base of the aedeagus on the left side, but on the right side is extended into a long spatulate lobe which covers all of the aedeagus except the extreme apex. See drawings.

Comparative notes. This species more closely resembles *vitripennis* Stal and *perlucidus* n. sp. than any others because of its same coloring, size, etc. It is separated from *perlucidus* by having rudimentary hind wings, while *perlucidus* has long ones; by having the anterior margin of vertex not produced beyond eyes, by having more wedge-shaped tegmina which are wider in line with apex of clavus, while in the former they are hemispherical, and finally by having a very narrow costal cell area which is not bent back as in *perlucidus*.

From *vitripennis* Stal it is distinguished by not having the vertex so produced anteriorly or not nearly as wide, by not having the anterior margin of pronotum notched as in that species, and by having the costal cell area much narrower, not bent back and with fewer cross veins in it. In addition, male specimens can easily be separated by the external appearance of the anal flap, which is much larger and two-pronged in *vitripennis*, but is only shallowly emarginate in *sinehamatus*.

Location of types and type locality. Described from fourteen specimens. Holotype, male, and allotype female taken at Apline, Cal., August 9, 1929, by Dr. R. H. Beamer. Three paratype males from same locality. One paratype female from Campo, Cal., August 10, 1935; one paratype male and seven paratype females from San Diego county, California, August 7, 1929, collected by Dr. R. H. Beamer. The types are in the Snow Entomological Collection, University of Kansas.

Neaethus similis n. sp.

(Plates LX, LXI, LXII, LXV)

ORIGINAL DESCRIPTION

Size. Length of body from apex of head to tip of tegmen, 3.9 mm. to 4.9 mm. Length of tegmen, 3.2 mm. to 4.6 mm.; greatest width of tegmen, 3.2 mm. to 4.6 mm.

Color. General color similar to *N. fenestratus.* Body reddish-tan. Vertex and pronotum margined in dark brown, a faint light streak indicated on median line; two round, reddish-brown depressed spots in middle of pronotum. Mesonotum yellowish-tan through middle, darker at sides. Eyes yellowish-tan, banded with red bands. Frons uniformly dark tan, disk on either side of median carina sometimes darkened, margins dark brown. Body dark or golden-tan, the edges of some of the segments dark brown, and in females the median border of the ovipositor valves blackish-brown; males more uniformly colored. Legs reddish-tan, sometimes washed in darker brown on carinae or the ends of segments; tips of the claws black. Tegmina amber, translucent, sometimes somewhat milky, but not as much so as in *N. jacintiensus.* Veins uniformly dark brown in females; in male longitudinal ones sometimes lighter.

Structural details. Head not much wider than pronotum. Vertex not as broad as in *jacintiensus* but narrower than *N. vitripennis,* being about four and one half times wider across anterior margin than at median line, and being produced beyond eye for at least one fourth length of lateral margin of vertex, the lateral margins of the latter considerably diverging posteriorly. Frons long, narrow, parallel-margined with greatly elevated lateral edges. Postclypeus comparatively short, about one fifth shorter than one lateral margin of the frons. Pronotum not notched behind the eye, as in *vitripennis,* its anterior margin considerably elevated and roundingly produced as an even hemisphere, its posterior margin shallowly convex, the lateral arms at side, behind eyes, about equal in length to one fourth pronotum along median line; two round pits in center of the disk. Mesonotum one third wider than length through middle, a deep groove along anterior border forming an arcuated line just posterior to margin of the pronotum; somewhat shallowly depressed through middle, leaving an elevated shoulder on each lateral fourth; a median carina sometimes faintly indicated. Shape of tegmen not as hemispherical as in many species, its greatest width in line with apex of clavus. Veins not as heavy as in *jacintiensus.* Cross veins fewer and parallel, thus making many parallel-sided cells, not so

much smaller at apex than elsewhere. Vein Sc_1 straight or only slightly curved outwardly, setting off a wide costal phlange, which is distinctly inflexed and is traversed by seven to nine cross veins, making practically all the cells at either end smaller than through middle. Veins Sc_2 and R usually with two branches, sometimes three; vein M pectinate, usually with six branches; vein Cu_1 branched near base, as in *vitripennis*, and is united at apex, where it bends ventrad to meet a branch of M, which results in a narrow phlange being set off for about one third of the apical margin. Hind wings rudimentary, folded once longitudinally.

Male genitalia. Anal flap (10th abdominal segment) of the male makes the species easily recognized, since its posterior margin is deeply emarginate, which gives it the appearance of being pronged. The tubular part is slender and has its outer margins somewhat bulging, so that its greatest distance is through middle. The eleventh segment shows as a ringlike lobe beyond the dorsal posterior margin of the tenth and bears a more triangular-shaped stylus than in many species.

The harpago, as viewed from a flattened lateral view, is a boot-shaped plate which is narrowed at the apex, then greatly bulged on the ventral side through the middle, after which it narrows again to a blunt, truncate apex, and at the base of this short projection bears an external ventrad-curving, slender hook.

The aedeagal structure in this species is complex, especially as regards the theca, which covers the aedeagus for most of its length. The apical portion of the aedeagus, which shows beyond the theca, is membranous and therefore wrinkled on its inner margin. On the left side the theca appears as a membranous tube with its opening about halfway from base of aedeagus. At this point the tips of two well-sclerotized hooks of the aedeagus show beyond the emarginate outer margin of the tube, the dorsal one a flat, sharply pointed process, attached somewhat near base, and the ventral one a shorter bifurcate process. The inner margin of the thecal tube extends caudad as a flat membranous lobe, whose posterior margin is slightly triangularly produced and beyond which the apex of a third flat, sharply pointed aedeagal process shows, which is attached near middle of aedeagus. On the right side the theca shows as a longer membranous tube with an opening near the apex and beyond which shows a sharply pointed, sclerotized hook of the aedeagus. From a microscope slide it is difficult to understand the twisting of the theca. Apparently the usual dorsal flap is split dorsad and the

lateral lobe has twisted around the aedeagus from a point midway on the aedeagus so that it makes it appear to have two openings.

Comparative notes. *Neaethus similis* n. sp. is very similar in superficial appearance to *vitripennis* and *jacintiensus* n. sp. It has, however, one of the most distinctive types of genitalia in the genus. These three species can be separated externally by the following characteristics: the anterior margin of the vertex is produced beyond eye for about one fourth the length of its lateral margin in *similis*, while in the other two is scarcely produced at all and the width across this margin is less in *similis*, being only about four and one half times the length on median line, while in *vitripennis* it is five times, and in *jacintiensus* five and one half. *Similis* has a longer and narrower frons and is about one fifth shorter at lateral margins than greatest length of clypeus; *jacintiensus* has the frons about equal in length and width, while *vitripennis* has a longer clypeus proportionally, its length being equal to one lateral margin of the frons.

The anterior margin of the pronotum is notched behind the eyes in *vitripennis*, but not in the other two. The tegmina show a few variations, the costal cell area is reflexed distinctly in *similis* and *vitripennis* but not in *jacintiensus;* vein M tends to branch more in *jacintiensus*, showing usually as many as seven branches, while *similis* frequently has six, and *vitripennis* only four. The anal flap of the male is pronged in *similis* and *vitripennis* and rounded in *jacintiensus*.

Location of types. Described from holotype male collected at Leona Heights, Cal., August 15, 1933; allotype female, Mt. Diablo, Cal., August 21, 1935; one paratype female, Mt. Diablo, Cal., and four paratype males from Mt. Diablo, Cal., collected by Dr. R. H. Beamer; one paratype female and seven males from Mt. Diablo, Cal., collected by P. Oman. These types are in the Snow Entomological Museum, University of Kansas, and the U. S. National Museum at Washington, D. C.

Neaethus jacintiensus n. sp.

(Plates LX, LXI, LXII, LXV)

ORIGINAL DESCRIPTION

Size. Length from tip of head to apex of tegmen is 4.3 mm. to 5.6 mm. Length of tegmen is 3.8 mm. to 4.8 mm.; width of tegmen is 2.4 mm. to 3.1 mm.

This is one of the largest species in the genus, approximating *N. fragosus* in size.

Color. General color light yellow washed in varying shades of

fuscous so that some specimens appear much darker than others. Vertex light brown to fuscous with broad, light-yellow margin and a median longitudinal band light. Eyes mottled brown. Prothorax light brown to dark except at margins and a median longitudinal line. Mesonotum light brown to reddish across the depressed middle portion, lateral bullae dark brown, the anterior margin and apex light yellow. Frons and clypeus uniform, in the lighter specimens being light-tan or yellow, with the clypeus slightly lighter; in the darker specimens being reddish-brown with the margins light yellow. The underside of body light yellow with touches of light green, especially on the third and fourth segments, or most of segments having the central parts of sclerites reddish-brown with margins light yellow and the abdomen dark brown on the third to sixth segments. Legs light yellow or reddish-brown, tips of claws black. Tegmina milky translucent with either dark-brown veins entirely or some of the longitudinal veins lighter.

Structural characteristics. Head not much wider than pronotum. Vertex broad, its width across anterior margin about five and one half times its length at middle, the anterolateral corners not any produced beyond the eyes, but the anterior margin slightly angulately produced at middle, the lateral margins distinctly diverging posteriorly. Pronotum four times wider than length at middle, gradually narrowed behind eye to a slender arm, but not at all notched. Mesonotum broadly triangular, much more than one third broader than long, depressed through middle with a median carina lacking or only slightly indicated. Length and width of frons equal, its lateral margins outwardly rounding and slightly elevated, a median carina present for three fourths its length, on each side of which the disk is depressed as far as the elevated lateral margins. Clypeus not as inflated as in some species, about one fifth shorter than greatest lateral margin of frons. Tegmen with greatest width about two thirds its length and at a point in line with apex of clavus and not in middle of wing as in *nigronervosus* or *fenestratus;* veins thick, many cross veins present, thus making many angulate cells, the cells at the apex short. Vein Sc_1 straight and long, extending to a point which is at least one third length of tegmen, the cells in the costal area uniform, rectangular cells. Veins Sc_2 and R usually each only two-branched; vein M pectinate with as many as seven branches as in *nigronervosus;* vein Cu branched nearer base than in other similar species, united again close to apex. Hind wings rudimentary, folded once longitudinally.

Male genitalia. Anal flap (10th abdominal segment) a broad, flat tube at base with its lateral basal margins parallel-sided, its ventral posterior margin extended as a short, broad flap with rounded apex. From a mounted specimen the eleventh segment is exposed as a ring-like segment, showing beyond the dorsal rim of the tube, and bears a fingerlike stylus which is as long as the apex of the flap.

From a flattened view each harpago appears as a flat, somewhat inflated lobe, which is broadest at about middle, where its ventral margin is outwardly rounded. At the posterior dorsal angle the harpago is expanded into a truncate flattened process which is abruptly bent ventrad and posteriorly on the inside, and on the outside bears a sharply pointed but short hook whose apex is directed directly ventrad.

The aedeagus, as viewed from the left side, appears as a slender. semicircularly curved tube, bearing two well-sclerotized processes, the basal one being much shorter, attached at base under the theca and ending about midway of aedeagus, only its apical part showing beyond theca as a curved hook, which is broader at base, then tapers to a sharp apex which gently curves ventrad. The other aedeagal process arises midway on aedeagus as a broad, knifelike structure, and gradually tapers to a fine point, which stops approximately at base of apical ninth of the aedeagus. On the right side the aedeagus is mostly covered by the theca. It shows a flat, bladelike process attached near base and ending at about the base of the apical third. The theca on the left side covers the aedeagus for about one fourth its length, and its posterior margin on this side is deeply emarginate. On the right side the theca extends tubelike to not quite the middle of the aedeagus, then has a dorsal flaplike extension which reaches almost to the tip of the aedeagus and is sharply pointed.

Comparative notes. N. jacintiensus is closely allied to *N. nigronervosus* Mel. and *N. fenestratus* Mel. It is separated from these species by several characteristics. It is much larger than either of the other two. The vertex is proportionally much wider and the length at middle much shorter; the posterior lateral margins distinctly diverge. The pronotum also is proportionally wider for its length. The mesonotum lacks a median carina which the other two usually have indicated. The tegmen in this species is not hemispherical and has its greatest width in line with apex of clavus instead of at middle. The cells of the tegmen near apex are short, not long and parallel-sided, as in *nigronervosus*, nor clustered at apex, as in *fenestratus*. The venation resembles that of *nigronervosus*

more than it does *fenestratus,* as M tends to be pectinate with many distinct branches.

N. jacintiensus n. sp. also resembles *N. similis* n. sp. For comparison of these two species see notes under this heading in the description of that species.

Notes on distribution. A large series of this species was taken in San Jacinto mountains, California, by Dr. R. H. Beamer. Other specimens have been taken at the following places in California: Campo, Big Bear Lake, Idyllwild, San Diego county, Giant Forest, and Beaumont.

Location of types. Holotype male, and allotype female collected in the San Jacinto mountains, California, by R. H. Beamer, August 21, 1929. Many female and male paratypes taken at the same time and the same places as listed above. The types are in the Snow Entomological Collection, University of Kansas.

Neaethus nigronervosus Melichar, 1906

(Plates LX, LXI, LXII, LXV)

Melichar, Leopold. Monographie der Issiden (Homoptera). Abh. k. k. Zoöl.-Bot. Ges. Wien, III, pt. 4, 1906.

Size. Length of body from apex of head to tip of tegmen, 3.2 mm. to 4.5 mm. Length of tegmen, 2.6 mm. to 3.7 mm.; width of tegmen, 1.5 mm. to 2.4 mm.

This species is one of the smaller species in the genus.

Color. This species generally darker than many in the genus. Vertex fuscous or somewhat dark tan through middle, margins and a median longitudinal band light yellow. Pronotum also fuscous or darkish all except margins and median light line. Mesonotum generally brown except light yellow on anterior border at apex, median carina and on lateral fourth except for two brown spots, one at extreme anterior, lateral corner and another in center of the bulla. Eyes variegated with brown. Frons all dark brown except light in the following places; all the outside margins, the median longitudinal carina, which forks slightly at apex so that the yellow spreads out into a spot on each side, and on each side a narrow, irregular longitudinal streak just mesad of each lateral margin. Genae with a brown streak anterior to eye, rest light yellow. Antenna yellow, washed in brown, with a dark brown clavola. Clypeus dark brown except for a median band down center and at each lateral carina. Prothorax and mesothorax on underside brown, margined in whitish yellow. Metathorax light. Abdomen of female blackish-brown except for a light spot in center of first few abdominal segments, an-

other at lateral corners of or entirely across the sixth and seventh abdominal sterna, all of the abdominal pleura, and the central portions of the ovipositor valves. Males with venter of thorax light yellow spotted with dark; abdomen yellow except the fifth, sixth, and seventh abdominal segments blackish brown. Legs brown except for yellow along the carinae and tip of claws, which are black. Tegmina milky translucent with dark brown to black veins.

Color variations. Melichar distinguished this species from *N. fenestratus* by stating that all the veins are black in *nigronervosus*, while in *fenestratus* the longitudinal veins are greenish and only the cross veins are blackish. In all the males of *nigronervosus* studied by the writer the longitudinal veins are always lighter than the transverse veins.

Furthermore, some males have the entire body light yellow washed in lighter reddish-brown.

Structural details. Vertex not deeply concave through middle nor produced anteriorly beyond eyes, the anterior margin straight or only gently rounding, its width across anterior margin four times its length at middle. Frons rectangular, the lateral margins only slightly converging at base, somewhat elevated and a median carina present, which lessens in height and finally disappears as it approaches the apex. Postclypeus as long as or longer than the lateral margin of frons. Pronotum broad, about four and one-half times its length at middle, its anterior margin rounding, but not much produced into vertex, narrowed behind eye to a thin arm, but not deeply notched in this region as in other species, two depressed pits in center of disk. Mesonotum concave through middle, raised on either side to a distinct bulla; a median carina present, and an arcuated groove at extreme anterior margin following the posterior margin of the pronotum but stopping at either bulla. Tegmina hemispherical in outline, its greatest width just anterior to apex of vertex; its length approximately one half greater than its width; veins thick but appearing somewhat thinner than *fenestratus*, many cross veins present, forming numerous, irregularly shaped cells, with those at apex long, narrow, and parallel-sided, vein Sc_1 widely separated from costal margin, arcuated inwardly rather than straight or the reverse and only extending posteriorly for a third or less of the wing; the other longitudinal veins not uniform as to their branches, frequently pectinate to the extent that Sc_2 may have three to four branches and M frequently five to seven; Cu usually only two branched and these branches frequently making a curve ventrad but not uniting. Hind wings reduced to a mere scale, without longitudinal fold.

Male genitalia. Anal flap (10th abdominal segment) short, not much more than a third longer than wide, the ventral posterior margin extending flaplike for less than half the total length, evenly rounding at apex. The eleventh segment more conspicuous than in some species, with a long, fingerlike stylus extending beyond the apex of flap.

Each harpago, as viewed from a flattened view, is a broad, inflated lobe whose ventral margin is strongly outwardly convex and whose dorsal margin is deeply concave at middle. The posterior dorsal corner is projected dorsad into a bifurcate process, the more dorsal hook slenderly pointed and abruptly recurved, the ventral hook directed caudad and bluntly pointed.

The aedeagus is a semisclerotized tube, the apical fourth of which is strongly recurved and somewhat narrowed. From a left view it shows two strongly sclerotized, flat, sharply pointed processes which are attached some place near base and extend caudad, one having a more dorsal position and following the curve in the aedeagus until it reaches the apical bend in the latter and the other laterad in position and extending for about the same distance caudad, but with its tip abruptly recurved. On the right side the aedeagus appears to show a similar lateral process of about equal size and shape as the one on the left side and the dorsal process shows from this view, too. The theca in this species is a simple semimembranous tube with its posterior margin on either side obliquely truncate.

Comparative notes. This species is one of the most variable species in the genus in size, coloring and certain structural details. Melichar apparently had only females on which to base his description. No males in any collection seem to fit his description of the veins which he stated were all black. The males seem to have lighter longitudinal veins, as in *fenestratus.*

N. nigronervosus resembles *N. fenestratus* and *jacintiensus* more than any other species. *Nigronervosus* and *fenestratus* are separated other than the male genitalia, which are vastly different, by only the following characteristics: the vertex in *nigronervosus* has a straight, or only slightly rounding anterior margin, while in *fenestratus* this margin is slightly angulate at middle; the costal cell area is extremely broad in *nigronervosus* due to the fact that vein Sc_1 bends inwardly instead of toward the costal margin as in the other species, where the area is quite narrow; the cells along the apex of the tegmen in *nigronervosus* are long, narrow and parallel-margined, while in *fenestratus* there is always a cluster of small cells at apex. This latter is the most distinctive thing between the two.

In addition to the above there are trends of differences in the wing venation which can be noted. These differences are not always apparent because there seems to be some variation in the species themselves due to the longitudinal veins breaking up into various patterns of reticulation. However, there is a marked tendency for vein M in *nigronervosus* to be pectinate, with from six to seven branches, and for these veins to bend down and encroach on the territory of the R vein, while in *fenestratus* M is usually only four-branched, its branches are usually in the dorsal half of the corium and the veins Sc_2 and R are more apt to be pectinate.

For comparison with *jacintiensus* see the description of the latter.

Notes on distribution. The type locality is given as Prescott, Ariz. Many specimens were studied from the following places in Arizona: Yarnell, Chiricahua mountains, Granite Dell, Kirkland Junction and Maricopa county. A few specimens from Cedar City, Utah, were available.

Location of types. Female holotypes in the National Museum, Washington, D. C.

Neaethus fenestratus Melichar, 1906

(Plates LX, LXI, LXII, LXIII)

Melichar, Leopold. Monographie der Issiden (Homoptera). Abh. k. k. Zool.-Bot. Ges. Wien, III, pt. 4, 1906.

Size. Length of body from tip of head to apex of tegmen, 3.4 mm. to 4.2 mm. Length of tegmen, 2.9 mm. to 3.5 mm.; width of tegmen, 1.8 mm. to 2.6 mm.

This species approximates *nigronervosus* in size and is one of the smaller species in the genus.

Color. Melichar describes this species as having a pale green body and with wing covers transparent and longitudinal veins pale greenish, while the cross veins are entirely black. In a series of specimens from several localities these color characteristics seem variable. A female specimen from the National Museum Collection, bearing a Melichar determination label, is as follows: vertex yellowish-tan with the thin, sharp margins dark brown, pronotum yellowish-tan with two round reddish pits midway of its length, extreme thin margins dark brown; mesonotum yellowish-tan except for a light reddish-brown spot at lateroanterior corner of the bulla and another on the posterior half of each bulla. Frons uniform yellow with dark-brown margins, postclypeus yellow except for six or seven pairs of faintly indicated oblique stripes; rest of head uniform yellowish-tan. Thorax and abdomen all yellowish-tan, except the

inner margins of each ventral valve of ovipositor. Legs yellow except for tips of spines and claws. Tegmina milky translucent; longitudinal veins light yellow or tan, cross veins dark brown.

Color variations. Specimens which the writer has placed under this species show many color variations. Some specimens show all the veins fairly light; others show them all to be dark brown. When the veins are all dark much fuscous is found on the rest of the body; vertex, pronotum, and mesonotum are washed in it or show it at the sides; on underside all the sclerites are mottled with it and the fifth, sixth and part of the seventh segments are entirely fuscous in the female.

Structural details. Vertex not produced beyond eyes, its anterior margin slightly angulate at middle, its width at this point four times the length of one lateral margin. Frons broad, approximately one fourth longer than width across basal line, its lateral margins elevated, several depressions or dimples on each lateral half, a median carina present for three fourths of its length. Postclypeus longer through middle than the lateral margin of the frons, a deep groove present at point of union of the two sclerites. Pronotum short and broad, not much narrower than head, its length at middle twice the length of the vertex at middle, its length behind eye abbreviated to a mere slender arm, the anterior margin not greatly notched out as in some species, two round depressions present in the middle of the disk. Tegmina hemispherical in outline, its length not quite one third greater than its greatest width, which is midway of the wing or anterior to apex of vertex. Vein Sc_1 short, not extending even as far as one third the entire length, much nearer the costal margin and not curved inwardly as in *nigronervosus*, the other longitudinal veins frequently forked just inside apical margin and with many cross veins forming a cluster of irregular small cells at apex of corium. Vein Sc_2 frequently pectinate with four branches present, vein R with two or three main branches, vein M is usually four-branched, but its branches are all in dorsal half of corium and vein Cu_1 has the usual two branches which approach each other just before apex, but do not unite, and due to the high position of the medial veins curve for only a short distance at apex. Hind wings reduced to a mere scale, without a longitudinal fold.

Male genitalia. Anal flap (10th abdominal segment) short, not much over one fourth longer than wide, its lateral margins curving outwardly, its ventral margin extended only a brief distance to form the flap proper, the extreme posterior margin of which is truncate.

The eleventh segment only slightly visible, its stylus moderately long, extending not quite to apical margin of the stylus.

Each harpago, as viewed from a flattened lateral view, is a broad, somewhat inflated lobe, whose ventral margin is strongly outwardly convex and whose dorsal margin is deeply and angulately concave. The posterior dorsal corner is projected dorsad into a triangular process, which is broad at base and then tapers to a slender, recurved apex, just ventrad of which is a small, recurved external hook.

The aedeagus is a semisclerotized tube, the apical fourth of which is strongly recurved and bluntly rounded at apex. From a left view it shows two distinct sclerotized processes, the most conspicuous one located more ventrad, attached somewhere near the base under the theca, then after emerging from the theca immediately dividing into two hooks, a short dorsal one which is sharply pointed, half the length of the other and points ventrad, the other one long, slender, not quite so sharply pointed and curved dorsad, ending at about the base of the apical fourth of the aedeagus; the second aedeagal hook on this side is partially concealed by the bifurcate process and shows only as a sharply pointed, flat blade between the dorsal short hook of the latter and the right thecal flap. On the right side the aedeagus has a flat, bladelike, sharply pointed process, lying closely adpressed to it, attached midway the length of the aedeagus and ending approximately at base of apical fourth. The theca is a semi-sclerotized tube, covering the aedeagus for about one fourth to one third its length and on the dorsal side is extended caudad as a broad, spatulate lobe which becomes slightly wider at its apex.

Comparative notes. This species resembles *N. nigronervosus* and *N. jacinticnsus* n. sp. more closely than any others. For comparison with these species see notes under this heading in the descriptions of the other species.

Notes on distribution. The type localities are given as Los Angeles, St. Cruz, and Claremont, Cal.

A specimen in the National Museum collection, bearing a Melichar determination label, is from Arizona. Specimens were on hand for study from the Chiricahua mountains, Congress Junction, Oak Creek Canyon, Santa Rita mountains and Gila, Ariz. A few specimens were studied from Silver City, N. Mex., and Cedar City, Utah.

Location of types. The types from Los Angeles and Santa Cruz, Cal., are in the National Museum collection at Washington, D. C. The Claremont, Cal., specimens, collected by Baker are in the Melichar collection.

Neaethus curvaminis n. sp.

(Plate LX, LXI, LXII, LXIV)

ORIGINAL DESCRIPTION

Size. Length of body from apex of head to tip of tegmen, 3.4 mm. to 4.1 mm. Length of tegmen, 2.8 mm. to 3.4 mm.; width of tegmen, 1.8 mm. to 2.3 mm.

This is one of the small species in the genus, approaching the size of *uniformus* and *diversus.*

Color. Typical general color stramineous as in *uniformus,* sometimes veins darker as in the *nigronervosus* group. Vertex and pronotum stramineous, with thin outer edges dark brown and a cream-colored median line. Eyes reddish-brown. Mesonotum dark tan with an arcuated light border around anterior margin, which bends posteriorly at either side and crosses each lateral bulla; the median carina and extreme apex also cream-colored. Frons uniformly stramineous with thin outer margins dark brown and median carina lighter. Clypeus yellow with a series of oblique brown bars on each side. Under and lateral sides of thorax and external genitalia golden yellow, abdominal segments cream or light green. Inner margins of ovipositor valve dark brown. Legs washed in reddish-brown; tips of claws black. Tegmina stramineous throughout, usually with the veins the same color.

Color variations. Some specimens have the frons, vertex, pronotum, and mesonotum infuscated to varying degrees and the veins of tegmina dark brown.

Structural details. Similar in appearance and structure to *uniformus* and *diversus.* Vertex narrow, being only twice as wide across its anterior border as a lateral margin or approximately twice as wide as eye, this anterior border rounding, and posterior margin abruptly elevated. Frons elongate, parallel-sided, not much narrowed across posterior or basal margin, lateral margins somewhat elevated, median carina not greatly pronounced, extending only three fourths of the total length. Postclypeus long, being as long as or a trifle longer than the lateral margin of the frons. Pronotum longer than in related species, being three times wider than greatest length, narrowed in the characteristic fashion behind the eyes to a slender, somewhat tapering lateral arm, but not notched at this point. Mesonotum broad, about twice as wide as long, an arcuated groove following the margin of the pronotum and a faint median carina indicated. Tegmina hemispherical in shape with costal and apical borders strongly rounding, their greatest width at middle of the

wing, clavus moderate in length, being only twice longer than distance beyond its apex. Vein Sc_1 moderately short, stopping approximately at apex of basal fourth of tegmen, inwardly arching so that the costal cell area is broad and being crossed by only four to six cross veins, making large, distinct cells which are always broader than long. In this species the other longitudinal veins usually have one extra branch, the characteristic pattern being Sc_2 either two- or three-branched, R three-branched, M five-branched with all its branches distinctly in the upper half of the wing, Cu_{1a} and Cu_{1b} combined before apex, but the combined vein not uniting with an M vein. Hind wings reduced to mere scales.

Male genitalia. Anal flap (10th abdominal segment) short, narrowed slightly at base, bulging through middle and ending on the ventral side in a truncate flap. The ringlike eleventh segment shows beyond the dorsal posterior margin and bears an elongate stylus whose apex extends beyond the tip of the flap.

Each harpago, as viewed from a flattened lateral view, appears as a pear-shaped plate, somewhat inflated through middle. At the posterior corner it is reflexed so that an internal phlange is formed for about one fourth its length. The outer posterior dorsal corner of the harpago is extended dorsad into a bluntly pointed hook and the extreme posterior inward corner of the phlange extends ventrad as a sharply pointed hook, the two hooks together making a bifurcate corner to this region of the harpago.

The aedeagus is a short semimembranous tube, which is somewhat broadened and bent forward at the extreme tip. On the left side it shows three processes, the longest being ventral in position, more heavily sclerotized and attached somewhat near the base of the aedeagus. It is strongly curved, tapers at the apex and ends at the point where the aedeagus curves cephalad. Another well-sclerotized but shorter hook is seen just above the former and extends only to about the middle of the aedeagus. Between these well-sclerotized hooks is a third, elongate semimembranous lobe which is only slightly longer than the dorsal hook. On the right side the aedeagus bears a sharply pointed, curved hook attached at apex of basal third and extending to base of apical third.

The theca in this species, as in *uniformus,* is conspicuous. It covers the aedeagus for a little over one fourth of its length as a tight-fitting tubular sheath. On the left side it ends truncately. On the right side its dorsal corner is extended caudad into a flat, triangularly-shaped flap, which extends slightly beyond the apex of the lateral aedeagal hook.

Comparative notes. This species is closely allied with *N. uniformus* and *N. diversus*. For comparison of the three species see notes under this heading in the description of *N. diversus*.

Notes on distribution and location of types. The species was described from numerous specimens taken at various places in Arizona.

Holotype male, collected July 10, 1933, and allotype female, August 14, 1935, at Granite Dell, Ariz., by R. H. Beamer. Five paratype males and five paratype females, also from Granite Dell, one paratype male and two paratype females from Santa Rita mountains, four paratype males and six paratype females from Oak Creek Canyon, one paratype male and two paratype females from Yarnell, two paratype males from Prescott, one paratype male, Gila, and one paratype each sex, Congress Junction, all collected by R. H. Beamer in July and August.

These types are in the Snow Entomological Collection at the University of Kansas.

Neaethus uniformus n. sp.

(Plate LX, LXI, LXII, LXIV)

ORIGINAL DESCRIPTION

Size. Length of body from tip of head to apex of tegmen, 3.6 mm. to 4.2 mm. Length of tegmen, 3.1 mm. to 3.6 mm.; width of tegmen, 1.8 mm. to 2 mm.

Color. Similar in color to *N. diversus*. General color, amber yellow. Vertex lighter cream yellow at posterior lateral corners, its anterior margin dark brown. Pronotum slightly darker than vertex, its margins also brown. Mesonotum like pronotum except for a light cream anterior border anterior to the arcuated groove, which continues as a light streak across the middle of each lateral bulla, ending at the sides as a spot; the median carina and median posterior margins also cream. Eyes spotted and ringed with reddish-brown. Most of frons amber, light cream along lateral borders and the thin outer margins dark brown. Clypeus amber with a broad median cream longitudinal band. Legs light yellow to amber, with carinae of femora cream and tips of tarsal claws black. Thorax and abdomen in both sexes cream. Ventral valves of ovipositor along the median line dark brown. Tegmina semiopaque light amber; all of veins cream except cross veins in cell Cu_{1b} and apex of clavus, which are sometimes dark brown.

Structural details. Vertex not produced much beyond eye, the anterior margin slightly rounding; four times wider at its anterior margin than its median length and twice the width of one eye; hind

margin abruptly elevated. Frons short, clypeus long, the greatest length of latter equalling the length of one lateral margin. Pronotum three and one half times the greatest length, narrowed behind eye but not notched, to form a slender, somewhat tapered lateral arm; disk depressed through middle with two round, faintly depressed spots in exact center. Mesonotum one third wider than long, a median carina present and an arcuated groove close to anterior margin, which ends at either side in a bulla. Tegmina more hemispherical in outline than in *diversus,* their greatest width approximately at middle; vein Sc_1 quite straight, and costal cell area only moderately wide, with six, seven or eight cross veins, so that the small cells in this area are usually square or approximately as wide as long. The longitudinal veins coarse in texture with characteristic branching for the genus; veins Cu_{1a} and Cu_{1b} either not united at all before apex or lost in the apical reticulation. Hind wings reduced to mere scales.

Male genitalia. Anal flap (10th abdominal segment) short, narrowed slightly at base, then broadening posteriorly. The ventral posterior edge of the tube extended into a rounded lobelike flap which is shorter than in most species but is a trifle longer than in *diversus.* The stylus of the eleventh abdominal segment is blunt and short.

Each harpago, as viewed from a flattened lateral view, appears as a pear-shaped plate, somewhat inflated or swollen through middle. At the posterior corner it is reflexed for about one third of its dorsal length. The extreme posterior edge of this reflexed portion is extended into two short, sharply pointed processes, one of which extends inwardly and dorsad and one of which extends caudad and externally.

The aedeagus is a short, semimembranous tube, the tip of which curves dorsad in a semicircular position. On the left side it shows three sclerotized hooks or lobes. The most heavily sclerotized of these is attached under the theca, somewhat near the base. Beyond the rim of the theca it shows as a bifurcate process bearing a pointed blade which extends to a point at base of apical third of aedeagus and a small, sharply pointed hook which projects inwardly and is usually partly concealed by the thecal hood. Another heavily sclerotized hook is attached near base of apical third and extends to about base of apical fourth. Just dorsad of this hook is a less-sclerotized lobate-process, which ends at about the same point as the latter. The theca in this species is conspicuous. It covers the aedeagus for about one third its length as a tight-fitting tubular sheath. Beyond this point the dorsal portion becomes expanded

into a large hood which from either side view is rather triangular in outline. In reality it is a plate which has been elevated along its middorsal line into a thickened ridge and has each lateral margin extended downward as a lobate flap which partially encloses the aedeagal hooks.

Comparative notes. This species is closely allied to the following species: *N. diversus* and *N. uniformus.* For comparison of these three species see notes under this heading in the description of *N. diversus.*

Notes on distribution and location of types. This species was described from a large series of specimens taken in the Santa Rita mountains, Arizona. Holotype, male, Santa Rita mountains, Arizona, August 17, 1932; allotype female same place, August 18, 1935, by Dr. R. H. Beamer. Eight paratype males and five paratype females were collected same place in July and August, by Dr. R. H. Beamer. Forty male paratypes and thirty-four female paratypes were collected same place by F. H. Snow, in June. All types in the Snow Entomological Collection, University of Kansas.

Neaethus diversus n. sp.

(Plates LX, LXI, LXII, LXIV)

ORIGINAL DESCRIPTION

Size. Length of body from tip of head to apex of tegmen, 3.8 mm. to 4 mm. Length of tegmen, 3.2 mm. to 3.3 mm.; width of tegmen, 2 mm.

This is a small and elongate species.

Color. Uniform, amber yellow or tan. Vertex, pronotum and mesonotum light yellow at margins, deeper through middle. Eyes brown. Frons uniform yellow with extreme margins dark brown. Clypeus light yellow with somewhat darker oblique bands on each side. Thorax and abdomen yellow tan, except basal abdominal segments of male pale whitish yellow. Legs yellowish, tarsus washed in reddish-brown, tips of claws black. Tegmina amber yellow, semitranslucent, veins thick and light cream, a few dark cross veins present in cell Cu_{1b}.

Structural details. Vertex narrow, only twice wider than width of eye, only slightly produced beyond eyes, its lateral margins diverging posteriorly. Frons one fifth longer than its width at posterior margin, its lateral margins greatly elevated and somewhat diverging near anterior or apical end; a median carina present for two thirds of its length. Length of clypeus equal to width of posterior

or basal margin of the frons. Pronotum twice as long at middle as the vertex, narrowed behind eye to a slender arm, forming a small tuberculate knob just back of the posterior lateral angle of the eye, but not deeply notched as in some species. Mesonotum on median line twice as long as pronotum, a median carina faintly indicated and two lateral ones even more faint than the middle ones. Tegmina somewhat elongate, flat, not much inflated; costal margin more parallel to margins of corium than in related species, veins thick and elevated, with longitudinal veins less pronounced; clavus long, at least twice and sometimes more than twice the distance from its apex to apex of wings; vein Sc_1 outwardly curving or at least sinuate so that some of the costal areolets are longer than wide or at most square; vein Sc_2 usually two-branched, vein R frequently four-branched, vein M four- or five-branched, all connected by cross veins of the same length which makes it difficult to determine on which vein the branches belong; vein Cu_1 branched at apex of basal third, then the branches combining or running very close together very near apex. Hind wings reduced to minute scales.

Male genitalia. Anal flap (10th abdominal segment) short, narrowed slightly at base, then broadening posteriorly. The ventral posterior edge of the tube extended into a rounded, lobelike flap which is shorter than in many species. The eleventh segment showing slightly beyond the dorsal edge of the tubular part as a small ringlike segment and with a short fingerlike stylus.

Each harpago from a flattened lateral view is an elongate lobe with its ventral margin strongly outwardly rounded and its dorsal margin shallowly concave through middle, after which the posterior third of this margin is reflexed, inwardly forming a narrow projection, the caudal angle of which is bifurcate, with a dorsal process which is bluntly rounded at end and projects inward and the ventral process which is sharply pointed and projected ventrad and externally.

The aedeagus is shorter than in some species, being a thick, tubular semisclerotized process which ends bluntly at apex in two lobes. On the left side it bears a sharply pointed, sclerotized process attached at middle and extending to about the apex of the middle third of the aedeagus. Just dorsad of this middle hook is a more lobate process. A second long, curved, well-sclerotized hook, partially covered by the theca, is attached somewhat near the base of the aedeagus and extends to the same distance as the median one. At a point where it emerges from the theca it bears a short, dorsal, sharply pointed spine. On the right side the aedeagus shows only

a median, slightly curved process. The theca is a cylinder around the basal third of the aedeagus, after which dorsad it extends over the aedeagus as a lobelike hood, which is slightly broader and longer on the left side than on the right.

Comparative notes. N. diversus is closely allied with *N. uniformus* and *curvaminis*. The three species are difficult to distinguish externally and the genitalia are more similar than in other species. The latter, however, do show variations, which are constant. Many slides of *uniformus* were made to prove this. The following external differences are helpful in distinguishing the three: *curvaminis* is more readily separated from the other two because the vein Sc_1 is distinctly arched inwardly, making the small cells in the costal area wider than long, in *uniformus* vein Sc_1 is straight and the costal cells are square, in *diversus* Sc_1 tends to curve outwardly, thus making the costal cells usually longer than wide; the number of cross veins in the costal area tends to vary in the three species, numbering four or five in *curvaminis* and *diversus*, and seven or eight in *uniformus;* the clavus in *diversus* is relatively longer, being more than twice as long as the distance from its apex to apex of tegmen, while in *curvaminis* and *uniformus* it is only approximately twice longer; the longitudinal veins branch more in *curvaminis* than in the other two, especially M, which is five-branched in *curvaminis* and only four in *uniformus* and *diversus;* in *diversus* the clypeus is relatively shorter, being equal only to the basal or posterior margin of the frons and in the other two it is equal to one lateral margin of the frons.

Location of types. Holotype male and allotype female, collected in the Santa Rita mountains, Arizona, by Paul Oman, June 27, 1933. Also twenty-nine female and twenty-one male paratypes collected during June at the same place and by the same collector. Also one male paratype collected June 12, 1933, and two others, August 18, 1935, by R. H. Beamer. The types and most of the paratypes in the National Museum, Washington, D. C.; the other paratypes in the Snow Entomological Collection, University of Kansas.

THE GENUS MISODEMA Melichar, 1906

Melichar, Leopold. Monographie der Issiden (Homoptera). Abk. k. k. Zoöl.-Bot. Ges. Wien., III, pt. 4, 1906.

Comparative notes. The most distinctive characteristics of this genus are the following: opaque tegmina with a coarse reticulation of thick, strongly elevated veins, a very short clavus, as compared to length of the tegmen and costal margin not inflected; scutellum

long with three prominent longitudinal carinae; wings lacking; hind tibiae with four strong spines.

Misodema reticulata Melichar, 1906

(Plates LXVI, LXVII)

Melichar, Leopold. Monographie der Issiden (Homoptera). Abh. k. k. Zoöl. Bot. Ges. Wien, III, pt. 4, 1906.

Size. Length of body from tip of head to apex of tegmen, 3.5 mm. to 4 mm.

Color. Uniform testaceous brown or gray-brown; tegmina same, but approaching amber when light is transmitted through them. Vertex light brown except anterior margin, lateral margins and median carina, which are light yellow. Frons uniform brown with a yellow median carina, narrow yellow lateral margins and a longitudinal row of yellow spots just mesad of each lateral margin. Pronotum brown with a cluster of round yellow spots on each lateral half. Mesonotum dark brown at base, lighter brown areas across apex. Tegmina opaque, uniformly dark brown, with elevated prominent veins, which are more yellowish than the cells. Underside of body and legs brown.

Structural characteristics. Head narrower than pronotum. Vertex subequal in length and width, depressed through middle, a weak median carina present, lateral margins elevated, anterior margins triangularly produced cephalad for a considerable distance beyond eyes, so that vertex and frons as viewed from the side form an acute angle. Frons about one fifth longer than wide, lateral margins rounding, greatest width across anterior third, anterior margin deeply notched to receive postclypeus, posterior margin as viewed from the cephalic aspect somewhat rounding. Clypeus about one half the length of the frons, slightly inflated. Pronotum collarlike, strongly produced anteriorly into the head, very narrowed at sides, deeply emarginate behind, and length through middle subequal to length of vertex at middle. Scutellum large, anteriorly greatly produced into pronotum, narrowly tapered at sides and moderately produced caudad to a rounded apex; three longitudinal carinae present. Tegmina longer than body, considerably inflated, at base broadly expanded, gradually narrowing toward apex; traversed by conspicuous thick veins making an irregular network so that the course of the longitudinal veins is obscured; clavus short, with its tip scarcely reaching to middle of anal margins, costal margin not inflected at base. Hind wings lacking. Hind tibiae with four spines.

Comparative notes. The outstanding structural characteristics of the species are the heavy reticulation of the tegmina, the short clavus, the strongly produced vertex, the collarlike pronotum, the tricarinate scutellum and the quardrispinose hind tibiae. It resembles most closely *Dictyonissus griphus* Uhler, but is easily distinguished from the latter by the appearance of the tegmina, which are opaque and hairless in *Misodema*, but translucent and covered with conspicuous hairs in *Dictyonissus.*

Location of type. National Museum, Washington, D. C.

Notes on distribution. Melichar listed this species from Mexico and Texas. The label on the type specimen states that it was collected in Texas, by C. V. Riley.

THE GENUS DICTYSSONIA, 1936

Ball, E. D. Some New Issids With Notes on Others (Homoptera, Fulgoridae). Proc. Biol. Soc. Wash. 49: 155-158, 1936.

Comparative notes. Doctor Ball in his description of the genus states that this genus is the size and form of *Dictyobia* Uhler and resembles it in several respects. It is separated from this genus by having definite bullae at the outer angles of the tegmina, uniformly finely reticulate tegmina, in which the major venation is almost lost in the reticulation and the posterior margins rounding together. The genus is separated from *Neaethus* Stål, Doctor Ball points out, by having tegmina much longer and narrower behind and finer reticulation and from the genus *Dictyssa* likewise, by having this finer reticulation.

In wing venation this genus fits in the tribe *Issini* rather than *Hysteropterini,* in which it is placed in the present key mainly because it has only vestiges of hind wings. The wing venation is as follows: Sc_1 lacking apparently, altho the veins forming the dark reticulation run together at the place where Sc_1 would be found and simulate a longitudinal vein; veins Sc_2 and R are fused for a short distance after leaving the main vein trunk and vein Sc_2 appears to have two branches and R three; vein M appears to have six branches, but with all of these three veins the longitudinal branches are not easily distinguished in the apical reticulation. Vein Cu_1 is distinctly a single vein and in this respect resembles the *Issini* and *Thioniini.* The hind tibiae bear two lateral spines.

There is only one species in the genus.

Dictyssonia beameri Ball, 1936

(Plates LXVI, LXVII)

Comparative notes. This is a medium-sized *Issid,* measuring 4.8 mm. to 5 mm. in length, testaceous-brown in color with semi-translucent, whitish-gray tegmina, thickly traversed with reddish-brown longitudinal veins and a fine pitch brown reticulation, so that superficially the insect has a peppered appearance.

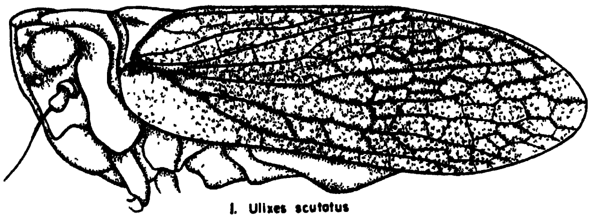
In his description Doctor Ball states that this species is the size of *Dictyobia permutata* Uhl., but is distinguished by having the elytra more inflated and rounding together behind, with definite bullae. It likewise has a finer reticulation, whiter wings, and much narrower vertex than this species.

Location of types and notes on distribution. Described from three examples taken in the Pinery Canyon, in the Chircahua mountains in Arizona. Holotype male and one paratype male in Doctor Ball's collection, Tucson, Ariz., and one paratype in the Snow Entomological Collection at the University of Kansas.

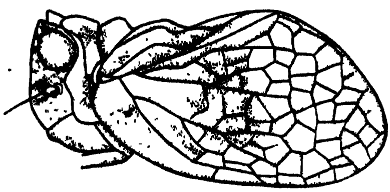
PLATE XLIX

1. Lateral aspect of *Ulixes scutatus* Walker.
2. Dorsal aspect of *Ulixes scutatus* Walker.
3. Lateral aspect of *Traxus fulvus* Metcalf.
4. Dorsal aspect of *Traxus fulvus* Metcalf.
5. Dorsal aspect of *Tylana ustulata* Uhler.
6. Dorsal aspect of head and thorax of *Euthiscia tuberculata* Van Duzee.
7. Lateral aspect of *Euthiscia tuberculata* Van Duzee.

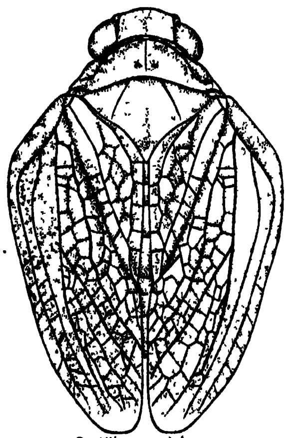
PLATE XLIX



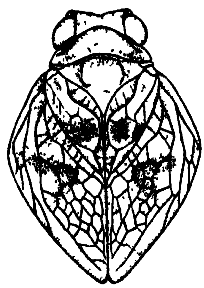
1. Ulixes scutatus



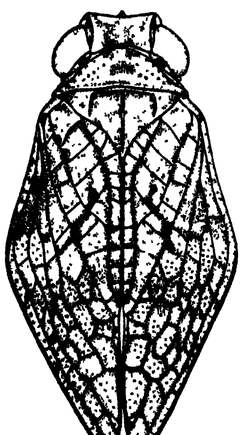
3. Traxus fulvus



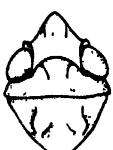
2 Ulixes scutatus



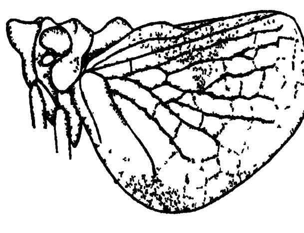
4. Traxus fulvus



5 Tylana ustulata



6. Euthiscia tuberculata

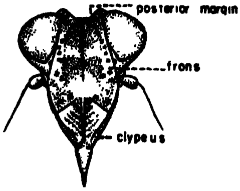


7. Euthiscia tuberculata

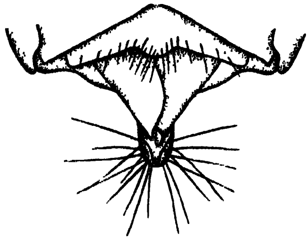
PLATE L

1. Frontal aspect of head of *Picumna ovatipennis* Walker, drawn from homotype in British Museum Collection.
2. Ventral aspect of female abdomen of *Picumna ovatipennis* Walker, drawn from homotype in British Museum Collection.
3. Dorsal aspect of *Picumna ovatipennis* Walker, drawn from homotype in British Museum Collection.
4. Dorsal aspect of *Picumna maculata* (Melichar).
5. Dorsal aspect of *Picumna chinai* n. sp.
6. Dorsal aspects of *Thionia simplex* (Germar).

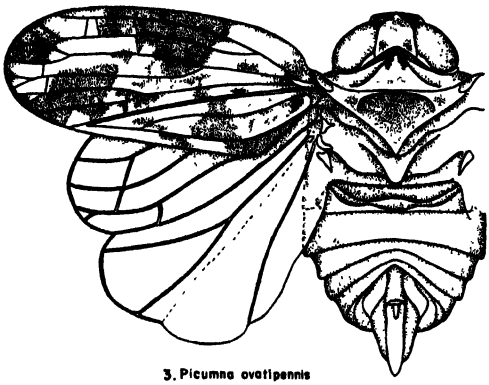
PLATE L



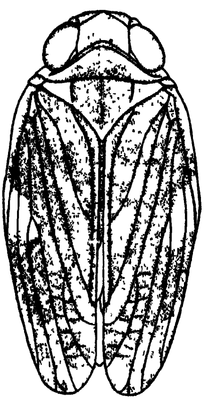
1. Picumna ovatipennis



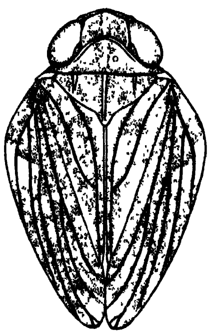
2. Picumna ovatipennis



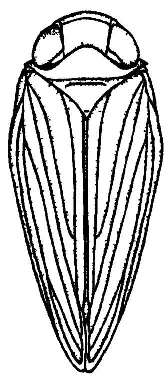
3. Picumna ovatipennis



4 Picumna maculata



5 Picumna chinai

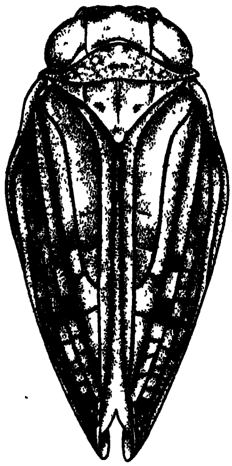


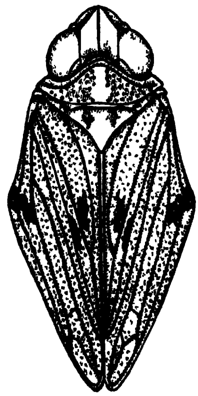
6. Thionia simplex

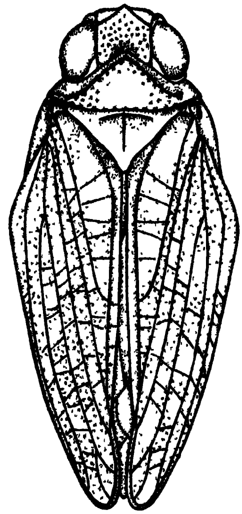
PLATE LI

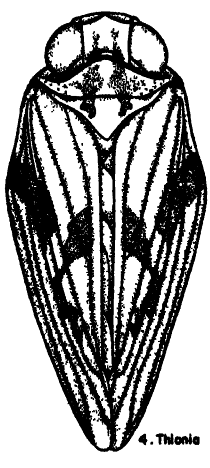
1. Dorsal aspect of *Thionia omani* n. sp.
2. Same view of *Thionia producta* Van Duzee.
3. Same view of *Thionia quinquata* Metcalf.
4. Same view of *Thionia bullata* Say.
5. Same view of *Thionia naso* Fowler.
6. Same view of *Thionia elliptica* (Germar).

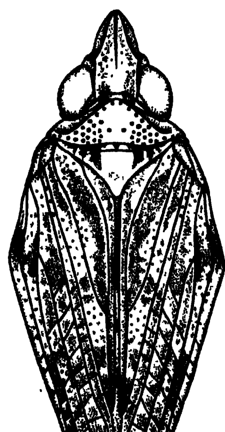
PLATE LI


1. Thionia omani


2 Thionia producta


3 Thionia quinquata


4. Thionia bullata


5. Thionia naso


6. Thionia elliptica

PLATE LII

1. Frontal aspect of *Ulixes scutatus* Walker.
2. Same view of *Traxus fulvus* Metcalf.
3. Same view of *Tylana ustulata* Uhler.
4. Same view of *Picumna chinai* n. sp.
5. Same view of *Thionia simplex* (Germar).
6. Same view of *Thionia elliptica* (Germar).
7. Same view of *Thionia bullata* Say.
8. Same view of *Thionia producta* Van Duzee.
9. Same view of *Thionia omani* n. sp.
10. Same view of *Thionia naso* Fowler.
11. Same view of *Euthiscia tuberculata* Van Duzee.
12. Same view of *Thionia quinquata* Metcalf.
13. Same view of *Picumna maculata* (Melichar).

PLATE LII

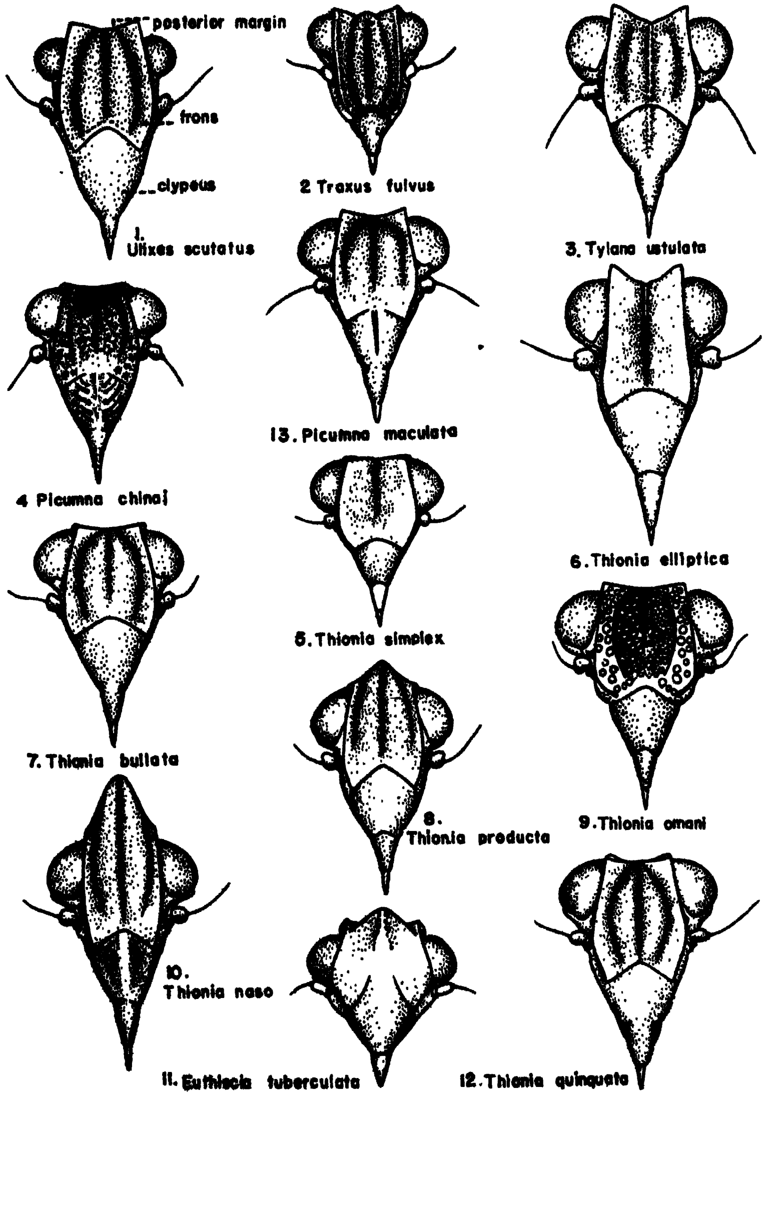
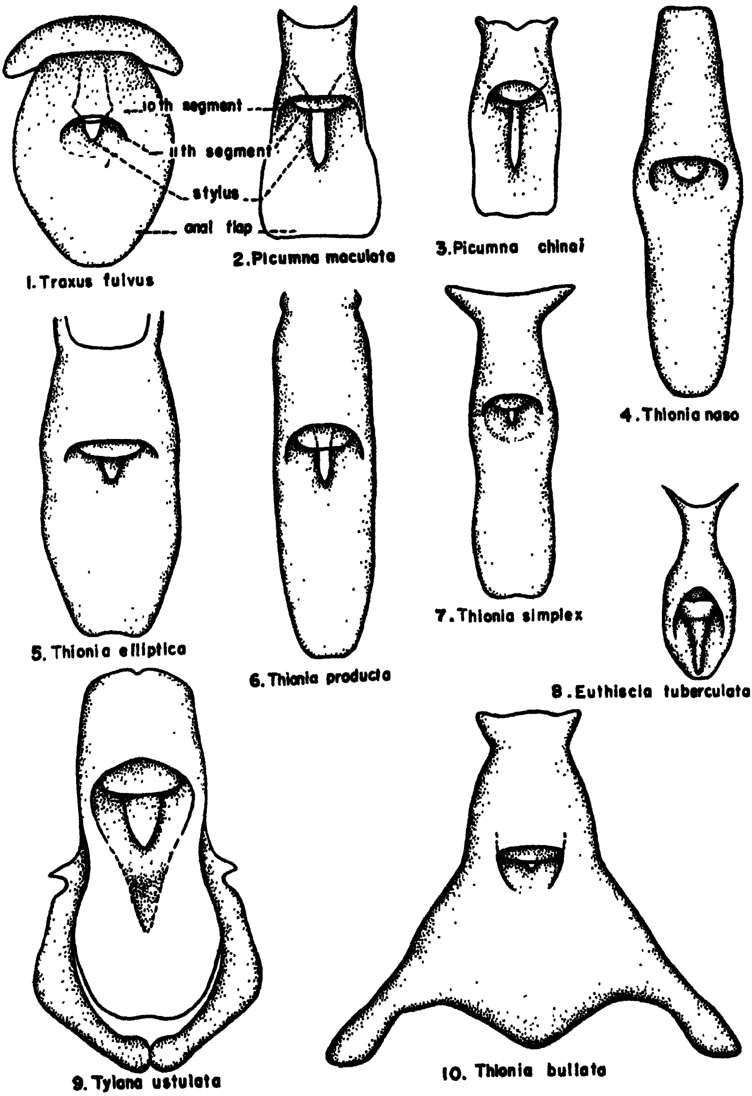

posterior margin
frons
clypeus
1. Ulixes scutatus
2 Traxus fulvus
3. Tylana ustulata
13. Picumna maculata
4 Picumna chinai
6. Thionia elliptica
5. Thionia simplex
7. Thionia bullata
8. Thionia producta
9. Thionia omani
10. Thionia naso
11. Euthiscia tuberculata
12. Thionia quinquata

PLATE LIII

1. Flattened dorsal view of anal segments (10th and 11th) of *Traxus fulvus* Metcalf.
2. Same view of *Picumna maculata* (Melichar).
3. Same view of *Picumna chinai* n. sp.
4. Same view of *Thionia naso* Fowler.
5. Same view of *Thionia elliptica* (Germar).
6. Same view of *Thionia producta* VanDuzee.
7. Same view of *Thionia simplex* (Germar).
8. Same view of *Euthiscia tuberculata* VanDuzee.
9. Same view of *Tylana ustulata* Uhler.
10. Same view of *Thionia bullata* Say.

PLATE LIII



10th segment
11th segment
stylus
anal flap
1. Traxus fulvus
2. Picumna maculata
3. Picumna chinai
4. Thionia naso
5. Thionia elliptica
6. Thionia producta
7. Thionia simplex
8. Euthiscia tuberculata
9. Tylana ustulata
10. Thionia bullata

PLATE LIV

1. Left view of aedeagus of *Picumna chinai* n. sp.
2. Ventral view of theca and aedeagus of *Picumna chinai* n. sp.
3. Same view of *Picumna maculata* (Melichar).
4. Left view of theca and aedeagus of *Tylana ustulata* Uhler.
5. Same view of *Picumna maculata* (Melichar).
6. Ventral view of theca and aedeagus of *Euthiscia tuberculata* VanDuzee.
7. Same view of *Tylana ustulata* Uhler.
8. Same view of abdomen showing aedeagus of *Ulixes scutatus* Walker, drawn from type material from British Museum Collection.
9. Left view of theca and aedeagus of *Euthiscia tuberculata* VanDuzee.
10. Dorso-posterior view of abdomen and aedeagal structure of *Ulixes scutatus* Walker from the type material in the British Museum Collection.

PLATE LIV

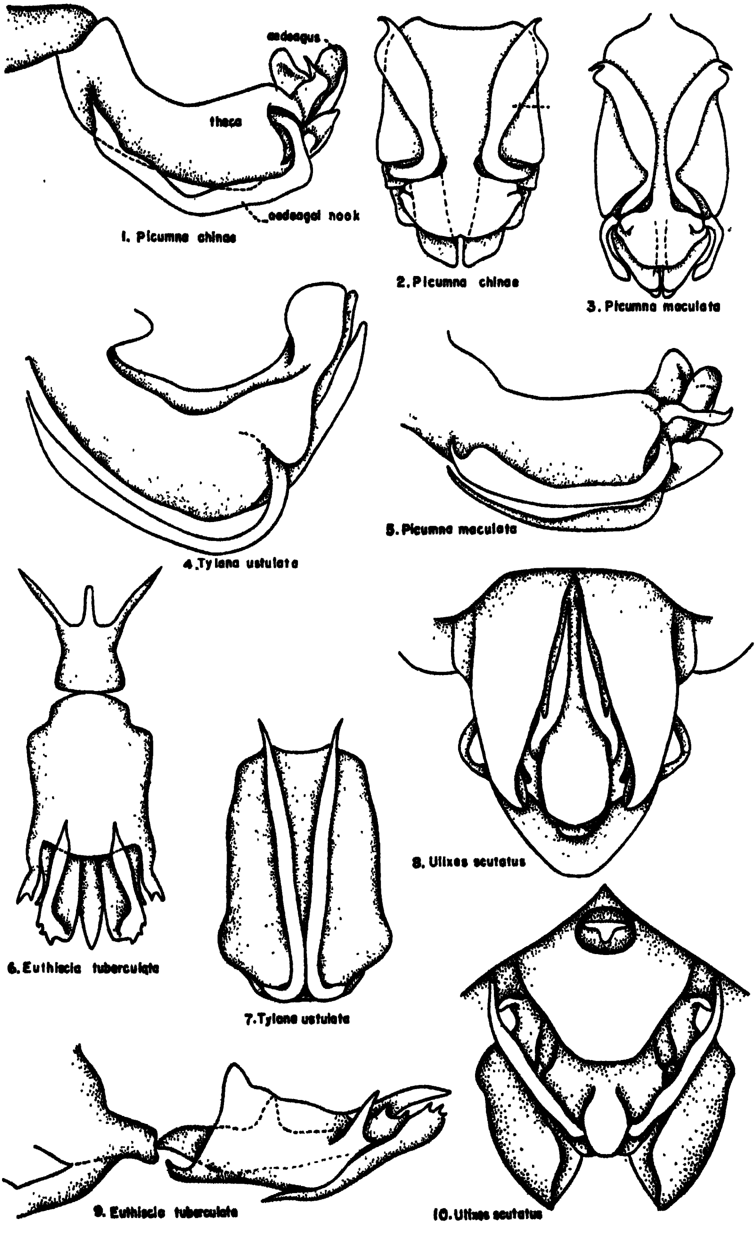

aedeagus
theca
aedeagal hook
1. Picumna chinae
2. Picumna chinae
3. Picumna maculata
4. Tylana ustulata
5. Picumna maculata
6. Euthiscia tuberculata
7. Tylana ustulata
8. Ulixes scutatus
9. Euthiscia tuberculata
10. Ulixes scutatus

PLATE LV

1. Left view of aedeagus and theca of *Thionia naso* Fowler.
2. Same view of *Thionia simplex* (Germar).
3. Same view of *Traxus fulvus* Metcalf.
4. Same view of *Thionia elliptica* (Germar).
5. Ventral view of aedeagus and theca of *Traxus fulvus* Metcalf.
6. Same view of *Thionia elliptica* (Germar).
7. Same view of *Thionia producta* VanDuzee.
8. Left view of aedeagus and theca of *Thionia producta* VanDuzee.
9. Ventral view of aedeagus and theca of *Thionia bullata* Say.
10. Left view of aedeagus and theca of *Thionia bullata* Say.

PLATE LV

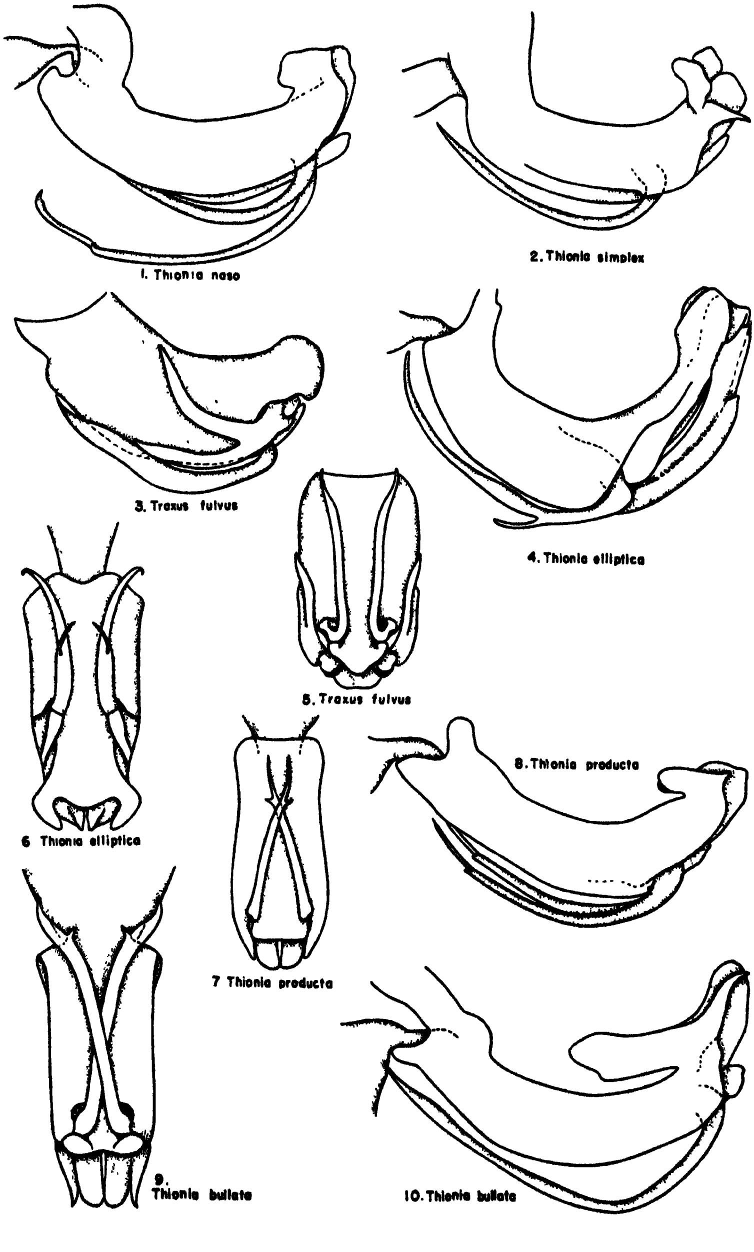

1. Thionia naso
2. Thionia simplex
3. Traxus fulvus
4. Thionia elliptica
5. Traxus fulvus
6 Thionia elliptica
7 Thionia producta
8. Thionia producta
9. Thionia bullata
10. Thionia bullata

PLATE LVI

1. Flattened lateral view of harpago of *Picumna chinai* n. sp.
2. Same view of *Picumna maculata* (Melichar).
3. Same view of *Euthiscia tuberculata* VanDuzee.
4. Same view of *Tylana ustulata* Uhler.
5. Same view of *Thionia simplex* (Germar).
6. Same view of *Thionia producta* VanDuzee.
7. Same view of *Thionia elliptica* (Germar).
8. Same view of *Traxus fulvus* Metcalf.
9. Same view of *Thionia bullata* Say.
10. Same view of *Thionia naso* Fowler.

PLATE LVI

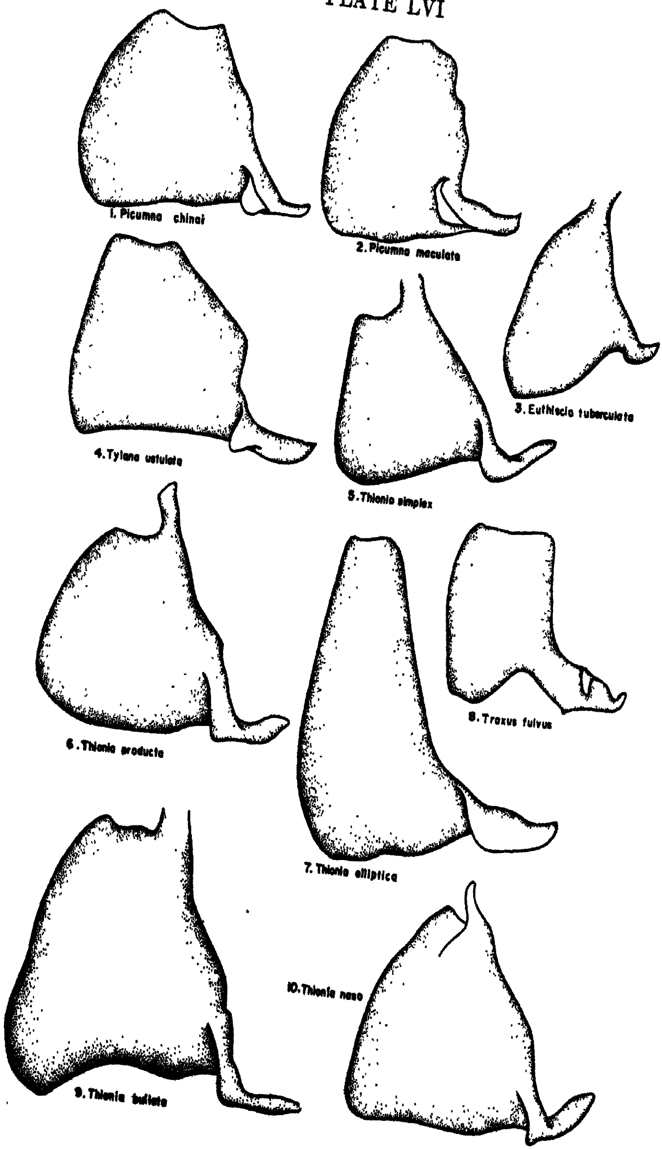
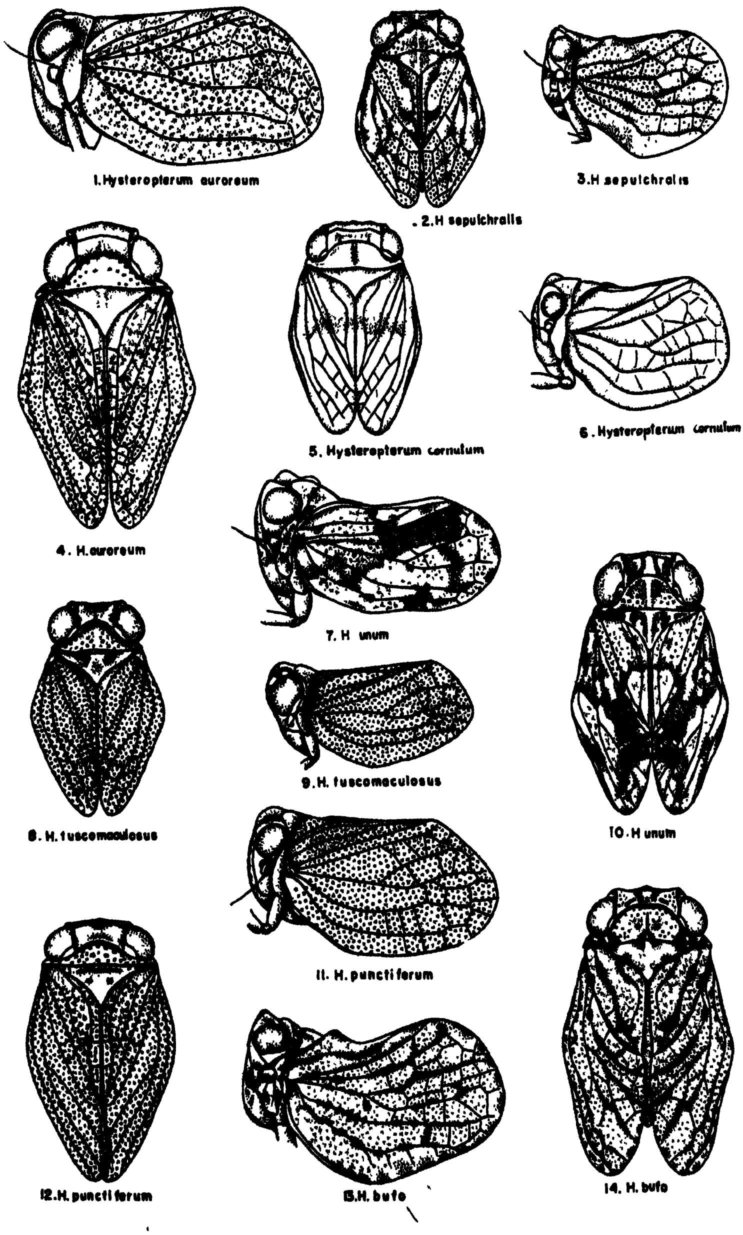

1. Picumna chinai
2. Picumna maculata
3. Euthiscia tuberculata
4. Tylana ustulata
5. Thionia simplex
6. Thionia producta
7. Thionia elliptica
8. Traxus fulvus
9. Thionia bullata
10. Thionia naso

PLATE LVII

1. Lateral view of *Hysteropterum auroreum* Uhler.
2. Dorsal view of *Hysteropterum sepulchralis* Ball.
3. Lateral view of *Hysteropterum sepulchralis* Ball.
4. Dorsal view of *Hysteropterum auroreum* Uhler.
5. Dorsal view of *Hysteropterum cornutum* Melichar.
6. Lateral view of *Hysteropterum cornutum* Melichar.
7. Lateral view of *Hysteropterum unum* Ball.
8. Dorsal view of *Hysteropterum fuscomaculosum* n. sp.
9. Lateral view of *Hysteropterum fuscomaculosum* n. sp.
10. Dorsal view of *Hysteropterum unum* Ball.
11. Lateral view of *Hysteropterum puntiferum* Walker.
12. Dorsal view of *Hysteropterum puntiferum* Walker.
13. Lateral view of *Hysteropterum bufo* VanDuzee.
14. Dorsal view of *Hysteropterum bufo* VanDuzee.

PLATE LVII



1. Hysteropterum auroreum

2. H sepulchralis

3. H sepulchralis

4. H. auroreum

5. Hysteropterum cornutum

6. Hysteropterum cornutum

7. H unum

8. H. fuscomaculosus

9. H. fuscomaculosus

10. H unum

11. H. punctiferum

12. H. punctiferum

13. H. bufo

14. H. bufo

PLATE LVIII

1. Frontal aspect of head of *Hysteropterum unum* Ball.
2. Same aspect of *Hysteropterum sepulchralis* Ball.
3. Same aspect of *Hysteroterum bufo* VanDuzee.
4. Same aspect of *Hysteropterum puntiferum* Walker.
5. Same aspect of *Hysteropterum auroreum* Uhler.
6. Same aspect of *Hysteropterum fuscomaculosum* n. sp.
7. Left view of aedeagus and theca of *Hysteropterum puntiferum* Walker.
8. Frontal aspect of head of *Hysteropterum cornutum* Melichar.
9. Left view of aedeagus and theca of *Hysteropterum fuscomaculosum* n. sp.
10. Same view of *Hysteropterum sepulchralis* Ball.
11. Same view of *Hysteropterum cornutum* Melichar.
12. Same view of *Hysteropterum auroreum* Uhler.
13. Same view of *Hysteropterum unum* Ball.

PLATE LVIII

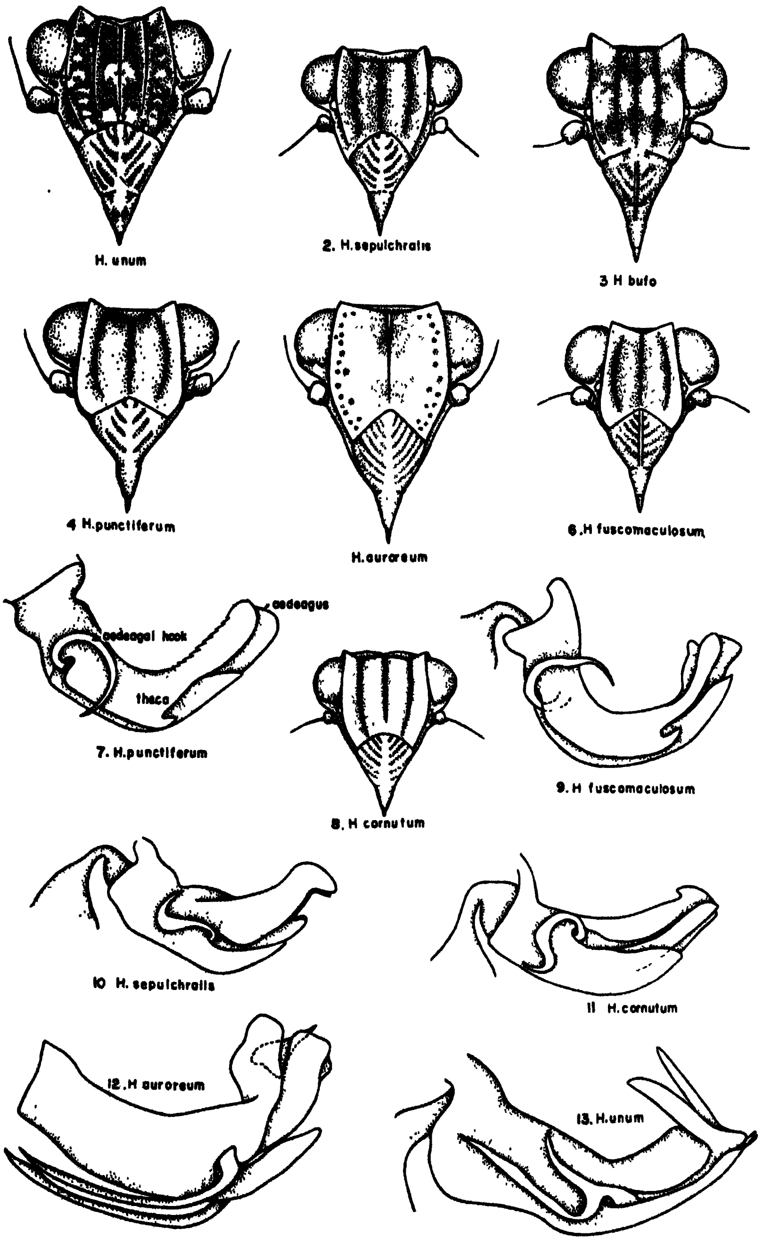

H. unum
2. H.sepulchralis
3 H bufo
4 H.punctiferum
H.auroreum
6 .H fuscomaculosum
aedeagus
aedeagal hook
theca
7. H.punctiferum
8. H cornutum
9. H fuscomaculosum
10 H. sepulchralis
11 H.cornutum
12 .H auroreum
13. H.unum

PLATE LIX

1. Flattened dorsal view of anal segments (10th and 11th) of female of *Hysteropterum unum* Ball.
2. Same view of male of *Hysteropterum unum* Ball.
3. Same view of female of *Hysteropterum auroreum* Uhler.
4. Same view of male of *Hysteropterum auroreum* Uhler.
5. Same view of male of *Hysteropterum cornutum* Melichar.
6. Same view of female of *Hysteropterum cornutum* Melichar.
7. Same view of female of *Hysteropterum fuscomaculosum* n. sp.
8. Same view of male of *Hysteropterum puntiferum* Walker.
9. Same view of male of *Hysteropterum sepulchralis* Ball.
10. Same view of female of *Hysteropterum sepulchralis* Ball.
11. Same view of male of *Hysteropterum fuscomaculosum* n. sp.
12. Same view of female of *Hysteropterum puntiferum* Walker.
13. Flattened lateral view of harpago of *Hysteropterum unum* Ball.
14. Same view of *Hysteropterum sepulchralis* Ball.
15. Same view of *Hysteropterum cornutum* Melichar.
16. Same view of *Hysteropterum punctiferum* Walker.
17. Same view of *Hysteropterum fuscomaculosum* n. sp.
18. Same view of *Hysteropterum auroreum* Uhler.

PLATE LIX

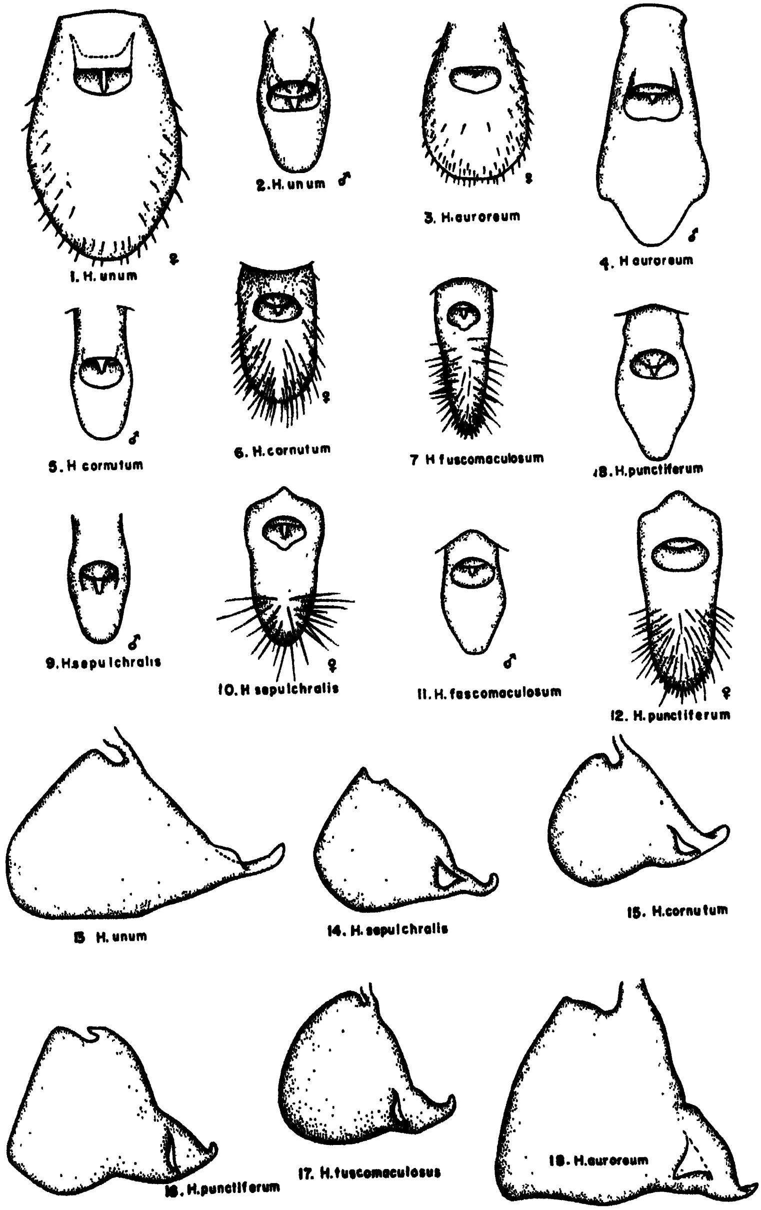

1. H. unum ♀
2. H. unum ♂
3. H. auroreum ♀
4. H auroreum ♂
5. H cornutum ♂
6. H. cornutum ♀
7 H fuscomaculosum
8. H. punctiferum
9. H. sepulchralis ♂
10. H sepulchralis ♀
11. H. fuscomaculosum ♂
12. H. punctiferum ♀
13 H. unum
14. H. sepulchralis
15. H. cornutum
16. H. punctiferum
17. H. fuscomaculosus
18. H. auroreum

PLATE LX

1. Lateral aspect of *Neaethus fenestratus* Melichar.
2. Same view of *Neaethus curvaminus* n. sp.
3. Same view of *Neaethus diversus* n. sp.
4. Same view of *Neaethus uniformus* n. sp.
5. Same view of *Neaethus similis* n. sp.
6. Same view of *Neaethus perlucidus* n. sp.
7. Same view of *Neaethus fragosus* VanDuzee.
8. Same view of *Neaethus sinehamatus* n. sp.
9. Same view of *Neaethus maculatus* Melichar.
10. Same view of *Neaethus vitripennis* Stal.
11. Same view of *Neaethus nigronervosus* Melichar.
12. Same view of *Neaethus grossus* Melichar.
13. Same view of *Neaethus jacintiensus* n. sp.

PLATE LX

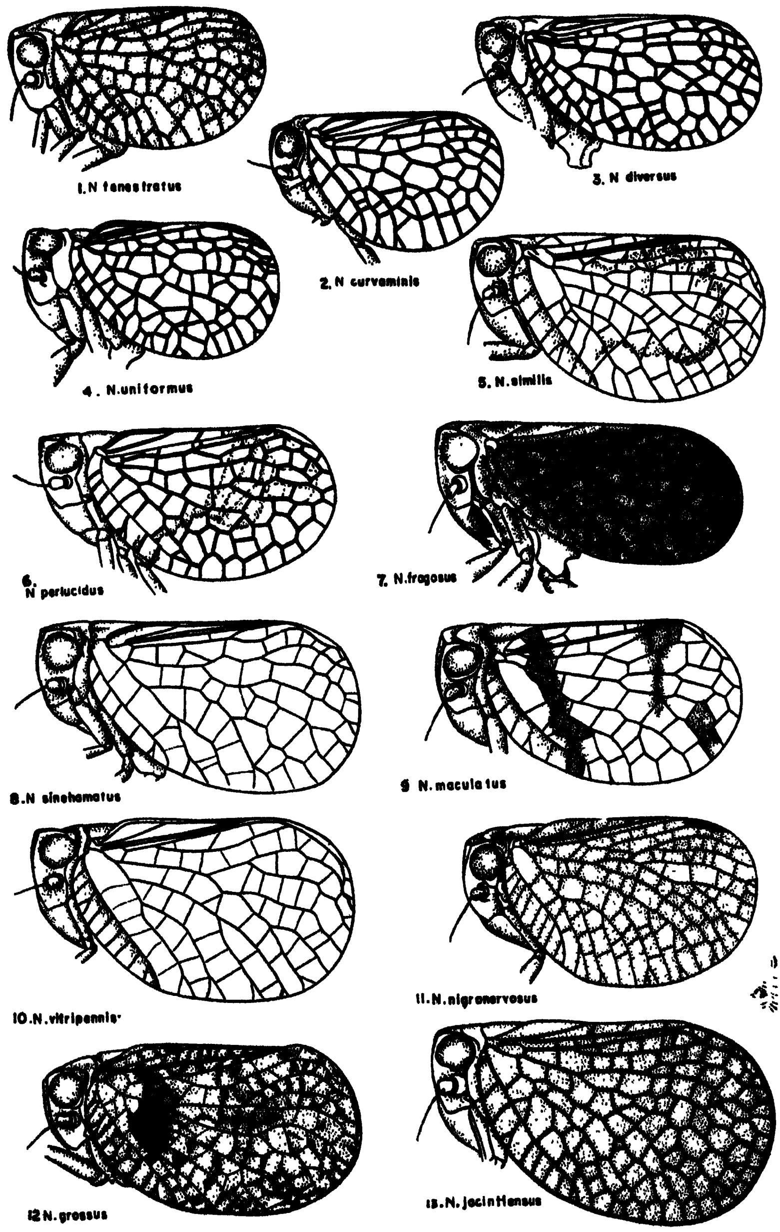

1. N fenestratus
2. N curvaminis
3. N diversus
4. N. uniformus
5. N. similis
6. N perlucidus
7. N. fragosus
8. N sinehamatus
9 N. maculatus
10. N. vitripennis
11. N. nigronervosus
12 N. grossus
13. N. jacinthensus

PLATE LXI

1. Dorsal aspect of head and pronotum of *Neaethus uniformus* n. sp.
2. Same view of *Neaethus curvaminis* n. sp.
3. Same view of *Neaethus diversus* n. sp.
4. Same view of *Neaethus fenestratus* Melichar.
5. Same view of *Neaethus nigronervosus* Melichar.
6. Same view of *Neaethus similis* n. sp.
7. Same view of *Neaethus maculatus* Melichar.
8. Same view of *Neaethus jacintiensus* n. sp.
9. Same view of *Neaethus perlucidus* n. sp.
10. Same view of *Neaethus vitripennis* Stal.
11. Same view of *Neaethus sinehamatus* n. sp.
12. Same view of *Neaethus grossus* Melichar.
13. Frontal aspect of head of *Neaethus uniformus* n. sp.
14. Same view of *Neaethus diversus* n. sp.
15. Same view of *Neaethus fenestratus* Melichar.
16. Dorsal aspect of head and pronotum of *Neaethus fragosus* VanDuzee.
17. Frontal aspect of head of *Neaethus nigronervosus* Melichar.
18. Same view of *Neaethus curvaminis* n. sp.
19. Same view of *Neaethus sinehamatus* n. sp.
20. Same view of *Neaethus grossus* Melichar.
21. Same view of *Neaethus similis* n. sp.
22. Same view of *Neaethus maculatus* Melichar.
23. Same view of *Neaethus perlucidus* n. sp.
24. Same view of *Neaethus vitripennis* Stal.
25. Same view of *Neaethus jacintiensus* n. sp.
26. Same view of *Neaethus fragosus* VanDuzee.

PLATE LXI

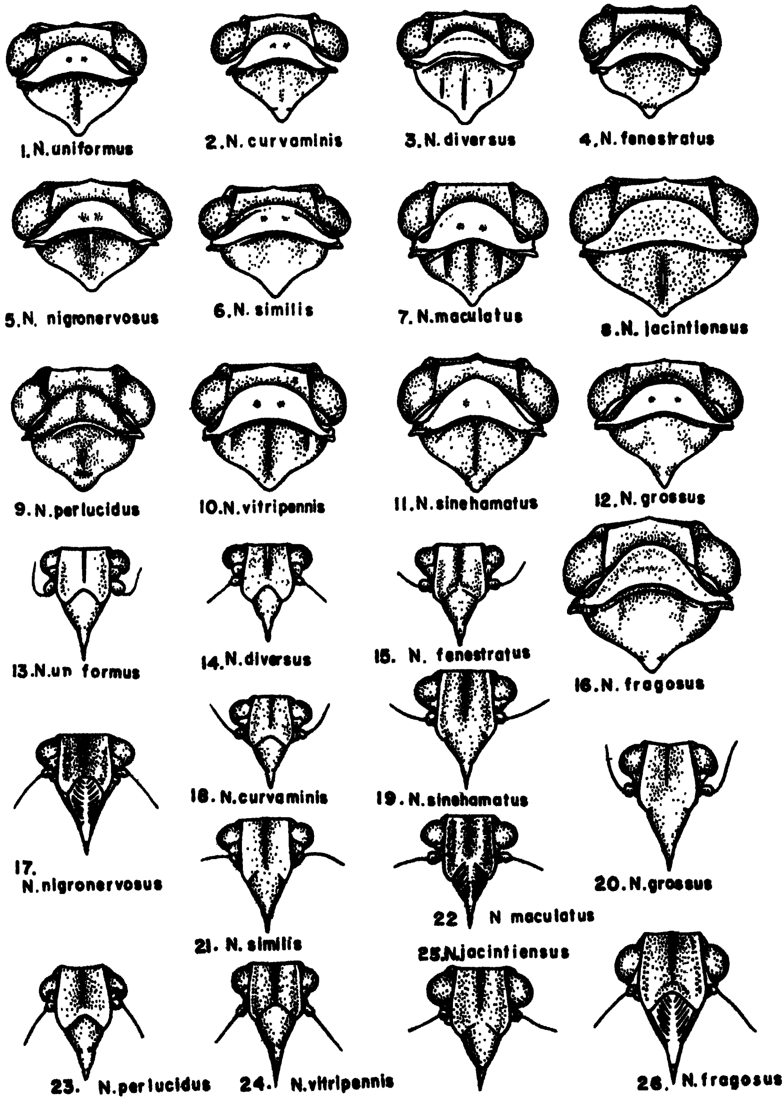

1. N. uniformus
2. N. curvaminis
3. N. diversus
4. N. fenestratus
5. N. nigronervosus
6. N. similis
7. N. maculatus
8. N. jacintiensus
9. N. perlucidus
10. N. vitripennis
11. N. sinehamatus
12. N. grossus
13. N. un formus
14. N. diversus
15. N. fenestratus
16. N. fragosus
17. N. nigronervosus
18. N. curvaminis
19. N. sinehamatus
20. N. grossus
21. N. similis
22 N maculatus
25 N. jacintiensus
23. N. perlucidus
24. N. vitripennis
26. N. fragosus

PLATE LXII

1. Flattened dorsal view of anal segments (10th and 11th) of male of *Neaethus uniformus* n. sp.
2. Same view of *Neaethus diversus* n. sp.
3. Same view of *Neaethus fenestratus* Melichar.
4. Same view of *Neaethus curvaminis* n. sp.
5. Same view of *Neaethus grossus* Melichar.
6. Same view of *Neaethus similis* n. sp.
7. Same view of *Neaethus vitripennis* Stal.
8. Same view of *Neaethus fragosus* VanDuzee.
9. Same view of *Neaethus jacintiensus* n. sp.
10. Same view of *Neaethus perlucidus* n. sp.
11. Same view of *Neaethus nigronervosus* Melichar.
12. Same view of *Neaethus sinehamatus* n. sp.
13. Flattened lateral view of harpago of *Neaethus nigronervosus* Melichar.
14. Same view of *Neaethus maculatus* Melichar.
15. Flattened dorsal view of anal segment of male of *Neaethus maculatus* Melichar.
16. Flattened lateral view of harpago of *Neaethus similis* n. sp.
17. Same view of *Neaethus uniformus* n. sp.
18. Same view of *Neaethus diversus* n. sp.
19. Same view of *Neaethus curvaminis* n. sp.
20. Same view of *Neaethus fenestratus* Melichar.
21. Same view of *Neaethus fragosus* VanDuzee.
22. Same view of *Neaethus grossus* Melichar.
23. Same view of *Neaethus jacintiensus* n. sp.

PLATE LXII

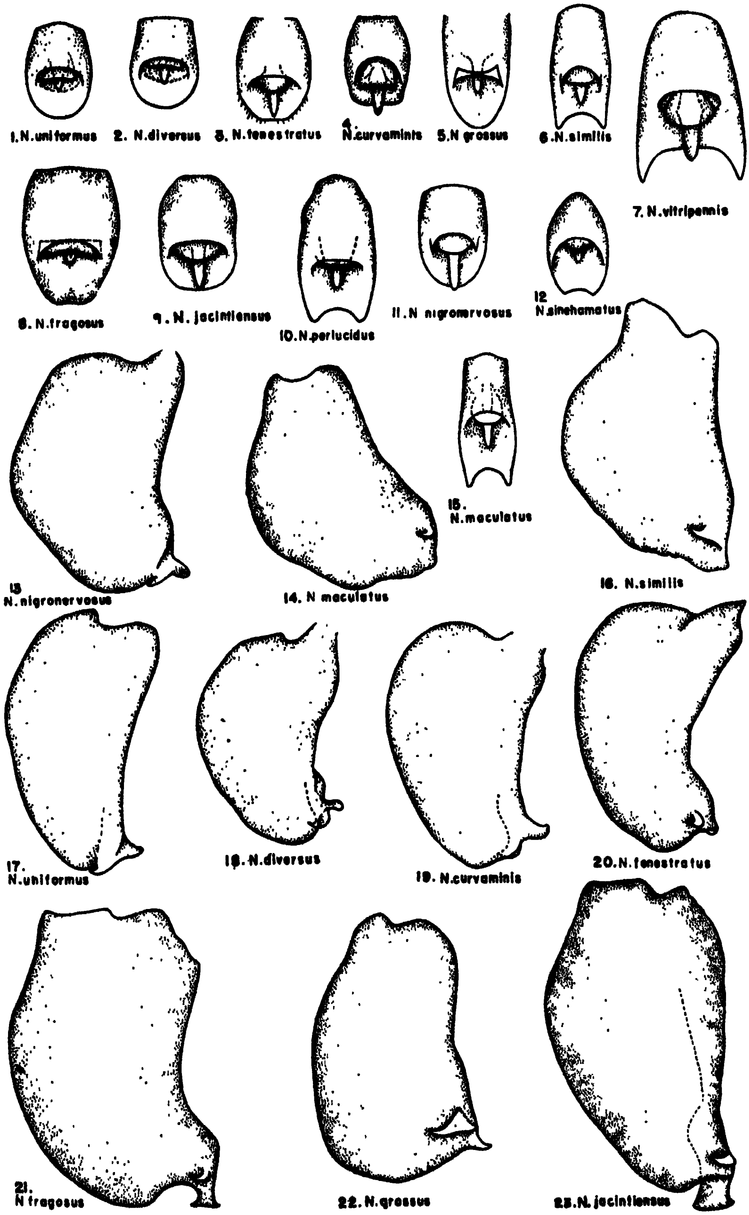

1. N.uniformus
2. N.diversus
3. N.fenestratus
4. N.curvaminis
5. N grossus
6. N.similis
7. N.vitripennis
8. N.fragosus
9. N. jacintiensus
10. N.perlucidus
11. N nigronervosus
12 N.sinehamatus
13 N.nigronervosus
14. N maculatus
15. N.maculatus
16. N.similis
17. N.uniformus
18. N.diversus
19. N.curvaminis
20. N.fenestratus
21. N fragosus
22. N.grossus
23. N. jacintiensus

PLATE LXIII

1. Left view of aedeagus and theca of *Neaethus perlucidus* n. sp.
2. Right view of aedeagus and theca of *Neaethus perlucidus* n. sp.
3. Left view of aedeagus and theca of *Neaethus sinehamatus* n. sp.
4. Right view of aedeagus and theca of *Neaethus vitripennis* Stal.
5. Right view of aedeagus and theca of *Neaethus sinehamatus* n. sp.
6. Left view of aedeagus and theca of *Neaethus vitripennis* Stal.
7. Flattened lateral view of harpago of *Neaethus sinehamatus* n. sp.
8. Same view of *Neaethus perlucidus* n. sp.
9. Same view of *Neaethus vitripennis* Stal.

PLATE LXIII

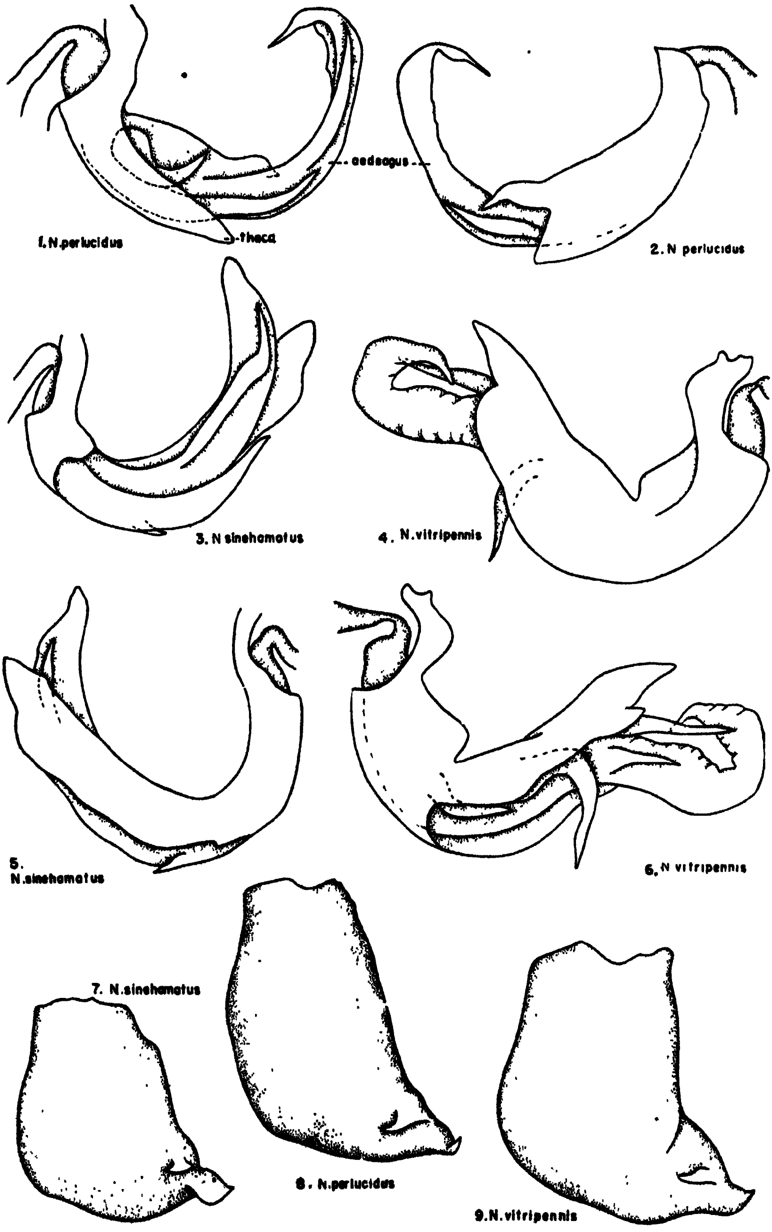
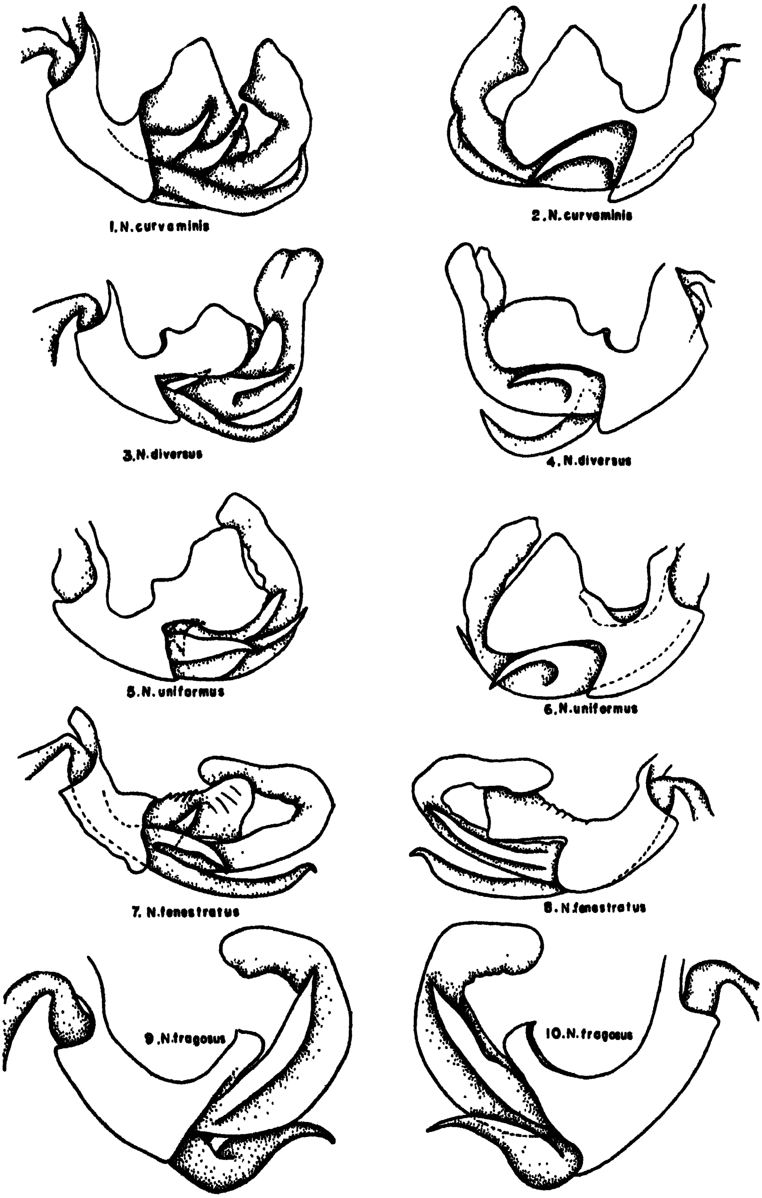

aedeagus
theca
1. N. perlucidus
2. N perlucidus
3. N sinehamatus
4. N. vitripennis
5. N. sinehamatus
6. N vitripennis
7. N. sinehamatus
8. N. perlucidus
9. N. vitripennis

PLATE LXIV

1. Left view of aedeagus and theca of *Neaethus curvaminis* n. sp.
2. Right view of aedeagus and theca of *Neaethus curvaminis* n. sp.
3. Left view of aedeagus and theca of *Neaethus diversus* n. sp.
4. Right view of aedeagus and theca of *Neaethus diversus* n. sp.
5. Left view of aedeagus and theca of *Neaethus uniformus* n. sp.
6. Right view of aedeagus and theca of *Neaethus uniformus* n. sp.
7. Left view of aedeagus and theca of *Neaethus fenestratus* Melichar.
8. Right view of aedeagus and theca of *Neaethus fenestratus* Melichar.
9. Left view of aedeagus and theca of *Neaethus fragosus* VanDuzee.
10. Right view of aedeagus and theca of *Neaethus fragosus* VanDuzee.

PLATE LXIV



1. N. curvaminis

2. N. curvaminis

3. N. diversus

4. N. diversus

5. N. uniformus

6. N. uniformus

7. N. fenestratus

8. N. fenestratus

9. N. fragosus

10. N. fragosus

PLATE LXV

1. Left view of aedeagus and theca of *Neaethus similis* n. sp.
2. Right view of aedeagus and theca of *Neaethus similis* n. sp.
3. Left view of aedeagus and theca of *Neaethus nigronervosus* Melichar.
4. Right view of aedeagus and theca of *Neaethus nigronervosus* Melichar.
5. Left view of aedeagus and theca of *Neaethus maculatus* Melichar.
6. Right view of aedeagus and theca of *Neaethus maculatus* Melichar.
7. Left view of aedeagus and theca of *Neaethus grossus* Melichar.
8. Left view of aedeagus and theca of *Neaethus jacintiensus* n. sp.
9. Right view of aedeagus and theca of *Neaethus grossus* Melichar.
10. Right view of aedeagus and theca of *Neaethus jacintiensus* n. sp.

PLATE LXV

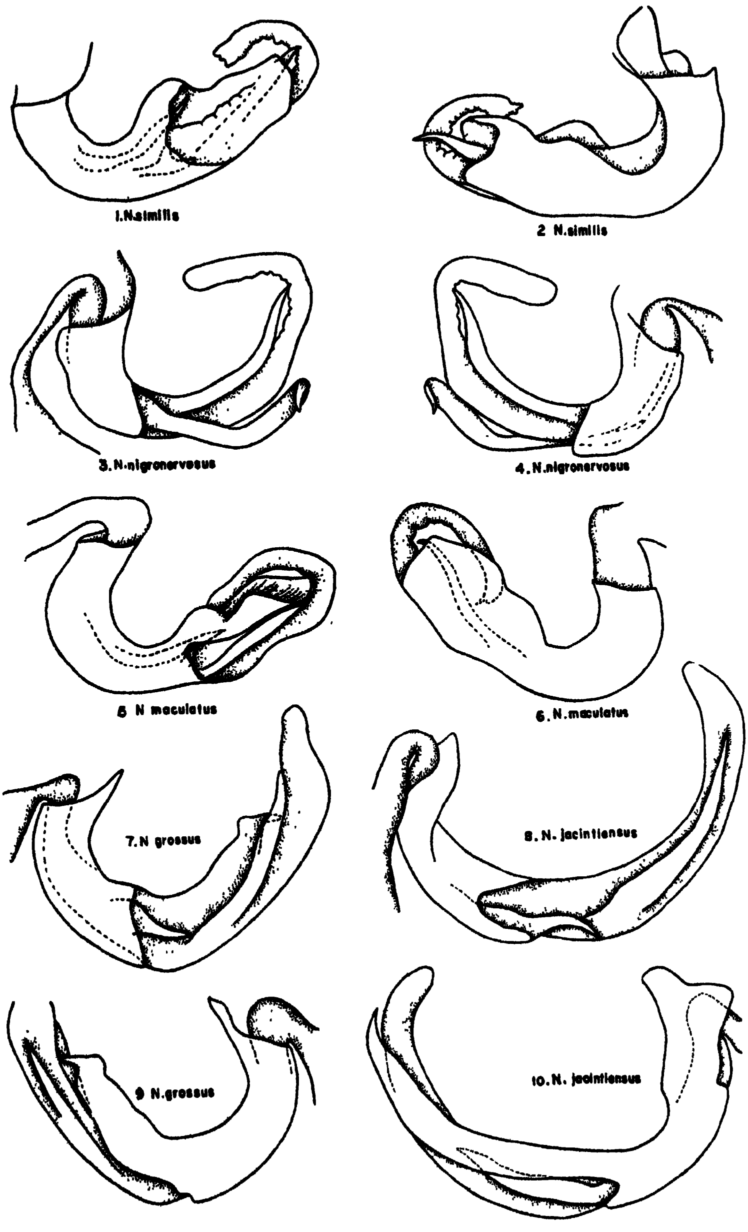

1. N. similis
2 N. similis
3. N. nigronervosus
4. N. nigronervosus
5 N maculatus
6. N. maculatus
7. N grossus
8. N. jacintiensus
9 N. grossus
10. N. jacintiensus

PLATE LXVI

1. Right view of theca and aedeagus of *Dictyonia obscura* Uhler.
2. Right view of theca and aedeagus of *Dictyonissus griphus* Uhler.
3. Left view of theca and aedeagus of *Dictyonissus griphus* Uhler.
4. Left view of theca and aedeagus of *Dictyonia obscura* Uhler.
5. Right view of theca and aedeagus of *Dictyonissus nigropilosus* n. sp.
6. Left view of theca and aedeagus of *Dictyonissus nigropilosus* n. sp.
7. Lateral aspect of *Dictyonia obscura* Uhler.
8. Lateral aspect of *Misodema reticulata* Melichar.
9. Dorsal aspect of *Misodema reticulata* Melichar.
10. Lateral aspect of *Dictyonissus griphus* Uhler.
11. Dorsal aspect of *Dictyonissus griphus* Uhler.
12. Dorsal aspect of *Dictyonissus nigropilosus* n. sp.
13. Dorsal aspect of *Dictyssonia beameri* Ball.

PLATE LXVI

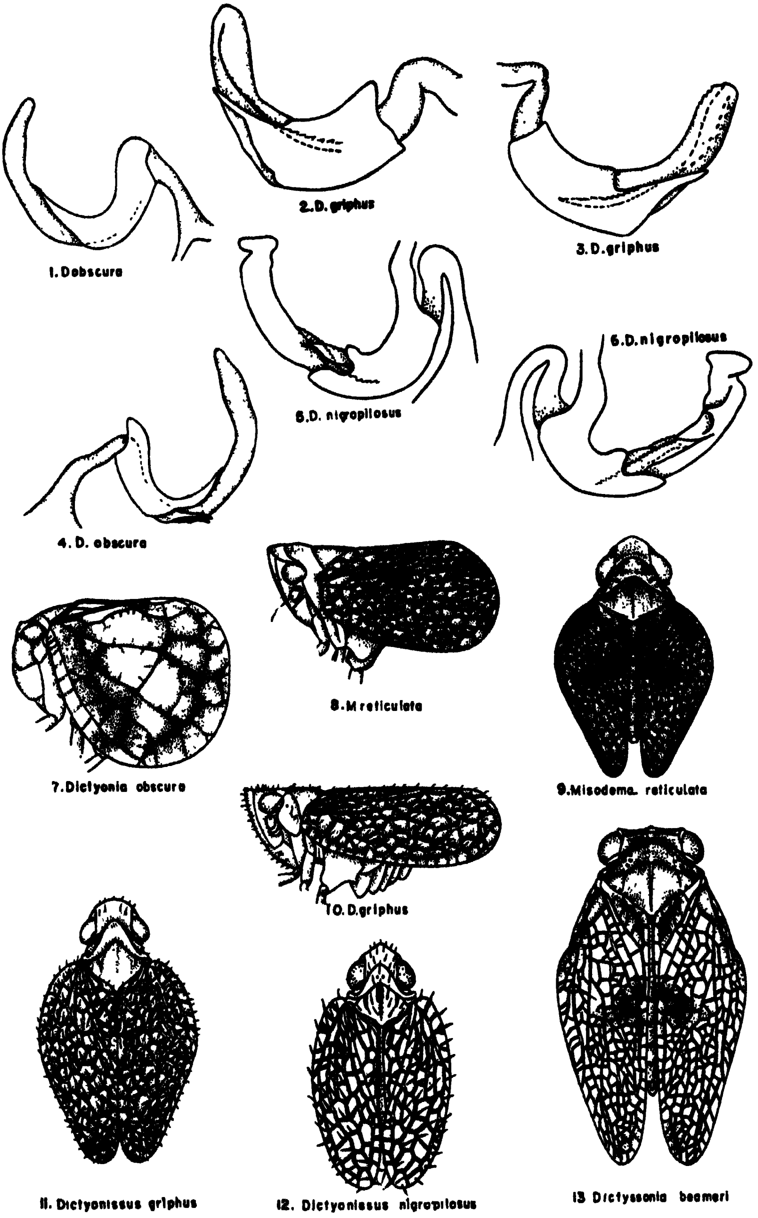
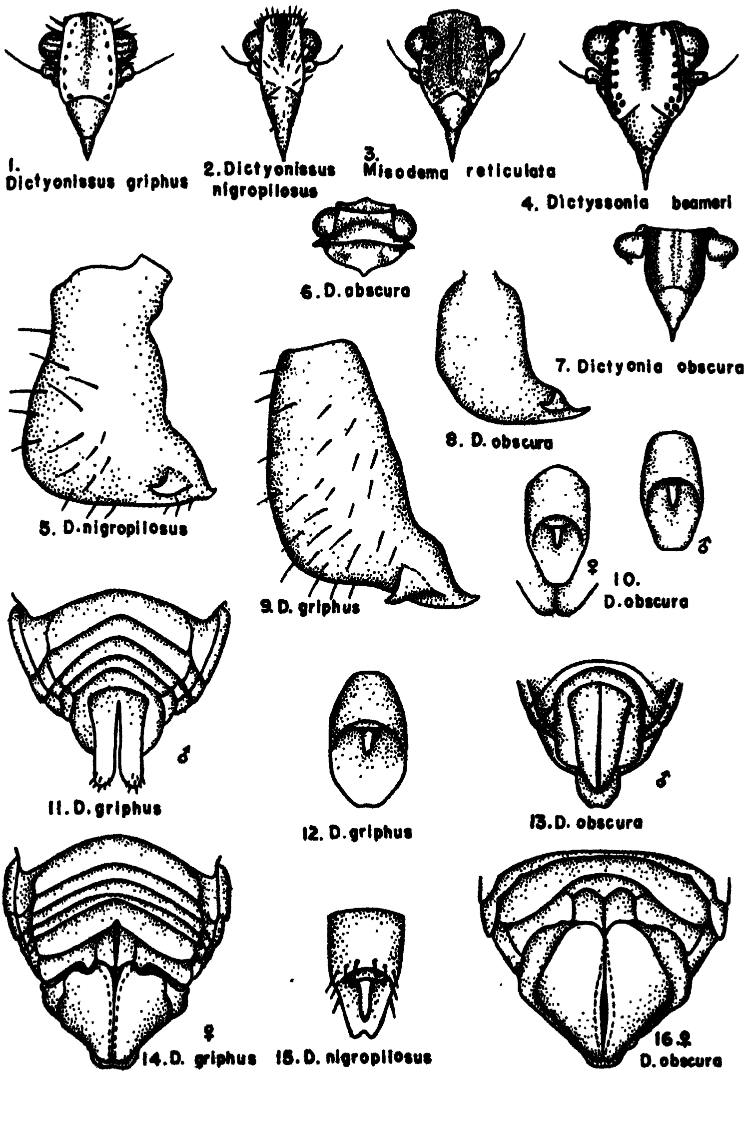

1. Dobscura
2. D. griphus
3. D. griphus
4. D. obscura
5. D. nigropilosus
6. D. nigropilosus
7. Dictyonia obscura
8. M reticulata
9. Misodema. reticulata
10. D. griphus
11. Dictyonissus griphus
12. Dictyonissus nigropilosus
13 Dictyssonia beameri

PLATE LXVII

1. Frontal aspect of head of *Dictyonissus griphus* Uhler.
2. Same view of *Dictyonissus nigropilosus* n. sp.
3. Same view of *Misodema reticulata* Melichar.
4. Same view of *Dictyssonia beameri* Ball.
5. Flattened lateral view of harpago of *Dictyonissus nigropilosus* n. sp.
6. Dorsal view of head and pronotum of *Dictyonia obscura* Uhler.
7. Frontal aspect of head of *Dictyonia obscura* Uhler.
8. Flattened lateral view of harpago of *Dictyonia obscura* Uhler.
9. Same view of *Dictyonissus griphus* Uhler.
10. Dorsal view of anal segments of male and female of *Dictyonia obscura* Uhler.
11. Ventral view of abdomen of male of *Dictyonissus griphus* Uhler.
12. Dorsal view of anal segments of male of *Dictyonissus griphus* Uhler.
13. Ventral view of abdomen of male of *Dictyonia obscura* Uhler.
14. Ventral view of abdomen of female of *Dictyonissus griphus* Uhler.
15. Dorsal view of anal segments of male of *Dictyonissus nigropilosus* n. sp.
16. Ventral view of abdomen of female of *Dictyonia obscura* Uhler.

PLATE LXVII


1. Dictyonissus griphus
2. Dictyonissus nigropilosus
3. Misodema reticulata
4. Dictyssonia beameri
6. D. obscura
7. Dictyonia obscura
5. D. nigropilosus
8. D. obscura
9. D. griphus
♀ 10. D. obscura ♂
11. D. griphus ♂
12. D. griphus
13. D. obscura ♂
♀ 14. D. griphus
15. D. nigropilosus
16. ♀ D. obscura

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The Morphology of the Carolina Mantis

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SECTION II: THE MUSCULATURE*

ABSTRACT: In this section of the study of the morphology of the Carolina mantis attention is concentrated upon the description of the musculature, but not exclusively, for the important functions of the muscles, obvious from dissections of fixed specimens, are discussed. The text is supplemented by twelve plates of penned drawings.

CONTENTS

INTRODUCTION

* Continued from Science Bull. Vol. XXIV, pp. 203-259, and submitted with it to the Department of Entomology and the faculty of the Graduate School of the University of Kansas in partial fulfillment of the requirements for the degree of doctor of philosophy. Part three to follow.

INTRODUCTION

FOR the past decade the close relationship of the insect skeleton and the musculature has been strongly emphasized. Some investigators insist that this relationship is so close the two structural systems must be discussed together under one heading. The discovery of the morphological and physiological relationship of the skeleton and musculature, as lately interpreted, is a worthy contribution to insect morphology, but it should not be run out of bounds. Scientific concepts should not be twisted into dogmas.

The functional intimacy between the skeleton and musculature does not force the musculature into a subservient morphological position. The musculature is derived from mesodermic embryonic tissue, a tissue different from the epidermis which forms the skeleton. In addition, the mode of development, the formation of coelomic sacs and the splitting into muscle groups, is very distinctive. Such fundamental differences warrant the consideration of the musculature as a morphological system coördinate with the skeleton, and in this study of the Carolina mantis, worthy of as detailed a treatment.

PART 1—THE CEPHALIC MUSCLES

The cephalic muscles of the Carolina mantis may be assigned to three groups, the facial, stomodeal, and gnathocranial muscles. With the exception of the antennal, all of the cephalic muscles of this insect are concerned with the function of feeding, directly or indirectly.

In the facial group there are six pairs of muscles:

1. The labral compressors (figures 1 and 8); a pair of V-shaped bundles extending from the basimedial region of the labrite to the adoral wall of the labrum (see figure 8). The contraction of these muscles flattens the basal portion of the labrum, thereby widening the prebuccal space.
2. The anterior labrals (figure 1); a pair of slender ribbonlike bands extending from the frontal sclerite, just below the median ocellus, to the median portion of the basal margin of the labrite. The labrum is extended forward by a short contraction of these muscles.
3. The posterior labrals (figure 1); slender, flat bands extending from the frontal sclerite, laterad of the anterior labral muscles, to the lateral tongues of the labrite (the so-called "tormae"). A short contraction of these muscles draws back the labrum against the mandibles. If the anterior and posterior labral muscles are fully contracted together, the labrum is retracted within the lower part of the epicranium. This retraction is frequently performed, especially when the mantis reaches for the entrails through a break in the skeleton of its victim.
4. The antennal levator* (figures 1 and 2); a short, wedge-shaped muscle extending from the anterior transtral arm to the upper part of the basal rim of the first antennal segment.
5. The median antennal depressor (figures 1 and 2); a short muscle extending from the anterior transtral arm to a tendon near the median portion of the basal rim of the first antennal segment.
6. The lateral antennal depressor (figures 1 and 2); a short muscle extending from the anterior transtral arm to the lateral portion of the basal rim of the first antennal segment.

The mechanism of the base of the antenna of this insect is an interesting one. The skeleton of the basal, or first, segment is articulated with the antennifer (the toothlike projection between muscles 5 and 6, figure 2: for more skeletal details see section I, Plate IX, figure 2), forming a single point articulation which permits considerable freedom of movement. The three muscles, 4, 5, and 6, are attached at the most advantageous points of the basal rim of the first segment, enabling the mantis to swing the entire appendage in a circle by variations of contractions.

* For ease in discussion it will be assumed that all muscles are paired, unless specifically designated as unpaired.

Within the antenna are two paired muscles:

7. The extensor of the flagellum (figure 7); a twinned muscle extending from the lateroventral basal region of the first antennal segment to the lateral portion of the basal rim of the second, or intermediate antennal segment. This muscle does not extend the second segment and the flagellum perfectly laterally, for the basal attachment of the muscle forces the muscle to pull the two distal segments partly downward.
8. The flexor of the flagellum (figure 7); a twinned muscle extending from the mediodorsal basal region of the first segment to the median portion of the basal rim of the second segment. The flexion of the second segment and the flagellum, like the extension, is not perfectly lateral because the basal attachment of the flexor forces the muscle to pull partly upward.

The buccal, pharyngeal, and esophageal portions of the insect alimentary tract are relatively indefinite regions of the stomodeal invagination, and muscles acting upon these regions may well be called stomodeal muscles in the Carolina mantis. In figure 8 only the left members of the pairs are shown.

9. The anterior buccal dilators (figure 8); two groups, usually four in each, of muscle bundles extending from the median area of the subfrontal sclerite to the anterior wall of the buccal region.
10. The first dilators of the pharynx (figure 8); a pair of short, flat muscles extending from the lower medial area of the frontal sclerite to the anterior wall of the pharynx.
11. The second dilators of the pharynx (figure 8); a pair of long muscles extending from the mediodorsal area of the frontal sclerite to the anterior pharyngeal wall.
12. The third dilators of the pharynx (figures 1 and 8); a pair of strong muscles extending from the ocular ridges near the anterior transtral arms to the sides of the pharynx.
13. The fourth dilators of the pharynx (figure 8); a pair of flat, fan-shaped muscles extending from the mediodorsal area of the frontal sclerite to the upper wall of the pharynx.
14. The fifth dilators of the pharynx (figure 8); a pair of long, flat, fan-shaped muscles extending from the apex of the frontal sclerite to the upper wall of the pharynx.
15. The first posterior buccal dilators (figure 8); a pair of short, thick muscles extending from the anterior bar of the transtral body to the posterior wall of the buccal region.
16. The second posterior buccal dilators (figure 8); a pair of small, thick muscles extending from the anterior bar of the transtral body to the posterior wall of the buccal region.
17. The sixth dilators of the pharynx (figure 8); two groups of thick, closely set muscle bundles extending from the upper surface of the anterior bar of the transtral body to the lower wall of the pharynx.
18. The seventh dilators of the pharynx (figure 8); two flaring muscles extending from the upper surface of the posterior transtral arms to the posterior lateral walls of the pharynx. These muscles, acting alone, flatten the posterior part of the pharynx, but, since the circular muscles

of this region are the primary constrictors, these seventh dilators are the antagonists to the circulars. However, to perform a dilation of this stomodeal region, these muscles must act in unison with the fifth pharyngeal dilators.

All of these stomodeal dilator muscles are the antagonists of the stomodeal circulars. When food is passed up before the mandibles the labral compressor muscles (1) flatten the labrum, enlarging the preoral space. The buccal dilators (9, 15, 16) contract to enlarge the mouth region for the reception of the food. After the food has entered the mouth the dilators relax and the buccal circular muscles contract, forcing the food backward in the stomodeum. As the buccal circulars contract the pharyngeal dilators (first 10, 11, 12, with 16 and 17, then 13 with 17, and finally 14 with 18) pull successively upon the pharyngeal walls. As the food is drawn posteriorly by the action of the dilators, the pharyngeal circular muscles force it backward. In the living animal these motions of dilation and contraction make the stomodeum ripple as bolt after bolt of food is forced toward the stomach.

The gnathocranial muscles are a complicated group, moving the cephalic postoral appendages and the salivary pocket:

19. The mandibular flexor (figure 3); a large, complex muscle extending from the dorsal area of the epicranium to the flexor tendon of the membrane near the mesal portion of the mandibular basal rim.
20. The mandibular extensor (figure 3); a flat, flaring muscle extending from the postocular area of the genal sclerite to the extensor tendon of the membrane near the lateral portion of the mandibular basal rim.
21. The flexor-adjustor of the mandible (figure 6); a short, stout muscle, extending from the outer surface of the anterior transtral arm to the inflection on the posterior surface of the mandible.

The flexor-adjustor muscles aid the mantis in breaking hard-shelled prey. They do not contribute a strong flexion for mastication, but they help to some degree. Their principle function is to produce an anterior-posterior movement to the mandibles. There is but a slight movement possible in this direction because of the relatively closely held articulatory points, but this slight movement is important. When the mantis tries to bite through a particularly testy beetle it contracts the large flexor muscles (19), holds, and then the flexor-adjustors contract alternatingly, giving the incisor processes a gnawing effect. These movements are quite comparable to our own efforts in dealing with the ordinary café steak.

22. The vestigial ventral adductor of the mandible (figure 6); a flat, wedge-shaped muscle extending from the midlateral area of the mandibular wall to the glottal sclerite 2 (see section I, Plate X, figures 11 and 14).

The vestigial ventral adductors have been homologized by Snodgrass with the ventral adductors of myriopods, diplopods, certain crustaceans and apterygotans. In the Carolina mantis these muscles have survived their usefulness. They do play a minor role, which will be discussed at another point.

The following muscles move the maxilla and its parts:

23. The cardinal rotator (figures 9 and 11); a three-part muscle extending from the posterior portion of the ocular ridge, 23a, and 23b, from the lateral region of the occipital sclerite, 23c, to the tendon of the cardinal process, 23a and 23c, and to the small tendon of the membrane near the cardinal process, 23b.

In section I, I interpreted the action of these muscles as an extension. This interpretation is incorrect. There is a slight lateral extension, but this movement is subordinate to the rotation of the cardo. In the rotation of the cardo 23a and 23b pull the cardinal process up toward the ocular ridge. As the cardinal process is pulled dorsally, the outer rim of the cardo is turned ventrally, and 23c completes the rotation by drawing the tendon of the cardinal process against the occipital sclerite. This rotation of the cardo gives the entire appendage a promotion, if the other maxillary muscles remain relaxed.

24. The median cardinal flexor (figure 12); a stout muscle extending from the outer surface of the transtral body to the median region of the cardo.
25. The distal cardinal flexor (figure 12); a two-part muscle extending from the outer surface of the transtral body to the distal portion of the cardinal rim and the upper lateral region of the stipes.

Both cardinal flexors use the cone (see section I, Plate X, figure 16, d) of the basal rim of the cardo as the articulatory point against the epicranium. The cardinal rotator begins the flexing movement by turning the cardo into an advantageous position. The rotation and the subsequent contraction of the flexor muscles extend the maxillary tip ventrally, and toward the median plane of the trunk.

26. The forcipital flexor (figures 9, 11, 12); a three-part muscle extending from the lateral edge of the stipes, 26a, from the upper medial region of the stipes, 26b, from the postocular portion of the genal sclerite, 26c, to the tendon of the membrane above the base of the forceps; 26c aids in flexing the maxilla as well as retracting it (see position of maxilla in figure 9).
27. The stipital flexor (figures 12, 13); a large muscle extending from the outer surface of the transtral body to the stipital ridge.
28. The accessory stipital flexor (figures 10, 13); a flat muscle extending from the outer surface of the transtral body to the median area of the stipes.

The maxilla of this insect is not extended laterally to any great degree. Most of the muscles are flexors, and, except for the partial extension performed by the cardinal rotator, the return of the maxilla to the relaxed position depends upon the resistance of the skeleton to the flexing action. In observing the living mantis I found that the maxilla is moved in a vertical direction, nearly parallel with the sagittal plane of the trunk. 26c lifts the appendage, and the combined action of cardinal rotator, cardinal flexors, and stipital flexors, extends the appendage ventrally and slightly toward the sagittal plane. This alternating retraction and extension, with the accompanying flexion and extension of the palp, gives the mantis the appearance of a mumbling old lady.

29. The flexor of the maxillary palp (figure 13); a small, flat muscle extending from the stipital ridge to the lower part of the basal rim of the first palpal segment.
30. The reductor of the maxillary palp (figure 13); a small, flat muscle extending from the stipital ridge to the posterior portion of the basal rim of the first palpal segment.
31. The extensor of the maxillary palp (figure 13); a small, flat muscle extending from near the stipital ridge to the upper portion of the basal rim of the first palpal segment.

There is no definite articulatory point between the basal palpal segment and the stipes, but the intervening membrane functions as an articulation. Its flexibility permits a free rotation, which is effected by variations in intensity of contraction of the three basal muscles.

32. The extensor of the second palpal segment (figure 13); a small muscle extending from the upper basal area of the first palpal segment to the upper portion of the basal rim of the second segment.
33. The flexor of the second palpal segment (figure 13); a slender muscle extending from the lower basal region of the first segment to the lower portion of the basal rim of the second segment.
34, 35, 36. The flexors of the third, fourth, and fifth palpal segments (figure 13); slender muscles extending from the lower portions of the basal rims of these palpal segments.
37. The pollicial productor (figure 10); a long, flat muscle extending from the upper portion of the stipes to the posterior basal rim of the pollex.

The labium and its parts, and the salivary pocket are moved by the following muscles:

38. The pollicial productor (figure 14); a long, slender muscle extending from the lower surface of the posterior bar of the transtral body to the membrane above the pollicial base.
39. The mental productor (figure 14); a large, flat muscle extending from the lower surface of the posterior bar of the transtral body to the

laterodistal edges of the mental plate. This muscle is the chief productor of the labium. The action of the pollicial productor is probably negligible.

40. The apical dilators of the salivary pocket (figures 5 and 14); a pair of flat muscles extending from the lateral edges of the labial stipites to the keel of the salivary pocket.
41. The basal dilators of the salivary pocket (figures 5 and 14); a pair of short, flat muscles extending from the central area of the labial stipites to the lateral edges of the salivary pocket.
42. The anterior dilators of the salivary pocket (figures 4 and 8); a V-shaped pair of muscles extending from the lateral glottal sclerites (section I, Plate X, figures 14, 2) to the median line of the anterior wall of the salivary pocket.
43. The retractors of the salivary pocket (figures 4, 5, 8); a pair of long, flat muscles extending from the lower surface of the posterior bar of the transtral body to the lateral edges of the salivary pocket.

These muscles acting upon the salivary pocket have no firm basal points of attachment, the so-called points of "origin." When the anterior dilators contract they pull back the lateral glottal sclerites, though these sclerites are held forward to some degree by the vestigial adductors of the mandibles. When the posterior dilators contract the labium is drawn forward to some degree.

44. The stipital reductors of the labium (figure 15); a pair of short, flat muscles extending from the central part of the mentum to the median part of the basal stipital rim.
45. The extensor of the labial palp (figure 15); a flat, flaring muscle extending from the lateral basal corner of the stipes to the upper portion of the basal rim of the first palpal segment.
46. The flexor of the labial palp (figure 15); a flat, fan-shaped group of bundles extending from the median margin of the stipes to the lower portion of the basal rim of the first palpal segment.
47. The extensor of the second palpal segment (figure 15); a group of small bundles extending from the upper basal region of the first segment to the upper portion of the basal rim of the second segment.
48. The flexor of the third palpal segment (figure 15); a slender muscle extending from the upper distal area of the first segment to the median portion of the basal rim of the third segment.
49. The pollicial reductors (figure 15); a pair of slender, flat muscles extending from the central part of the stipites to the posterior portions of the basal rims of the pollices.
50. The forcipital reductors (figure 15); a pair of long, slender muscles extending from the central part of the stipites to the posterior portions of the basal rims of the forcipes.

REFERENCES

There is little need for relisting the more important studies of the cephalic musculature of insects which are to be found in Snodgrass' "Morphology and Evolution of the Insect Head and its Appendages," Smiths. Misc. Coll., vol. 81, No. 3, 1928, and the shorter "Evolution of the Insect Head and the Organs of Feeding," Smiths. Rept. 1931, pp. 443-489. Little of any value has appeared since Snodgrass wrote those papers.

PLATE LXVIII

FIG. 1. Facial muscles of male head.

FIG. 2. Basal muscles of right antenna.

FIG. 3. Anterior view of flexor and extensor muscles of right mandible (♀).

FIG. 4. Anterior (¾) view of salivary pocket with posterior wall of glotta depending.

FIG. 5. Posterior view of salivary pocket.

FIG. 6. Basal details of musculature of right mandible.

FIG. 7. Intrinsic muscles of right antenna.

FIG. 8. Stomodeal muscles from median plane.

PLATE LXVIII

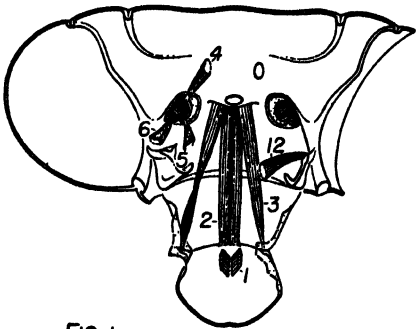


FIG. 1

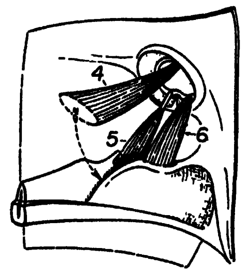


FIG. 2

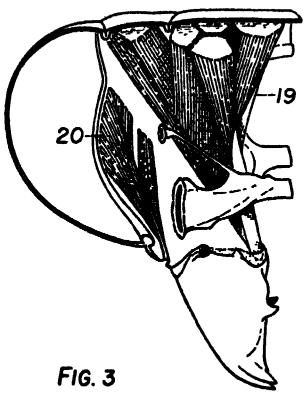


FIG. 3

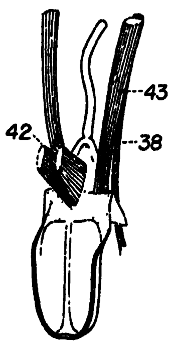


FIG. 4

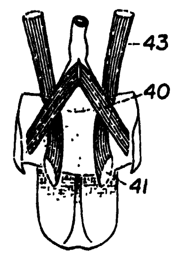


FIG. 5

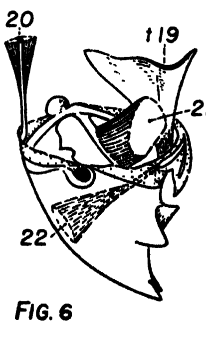


FIG. 6

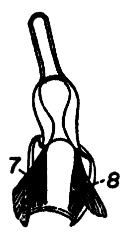


FIG. 7

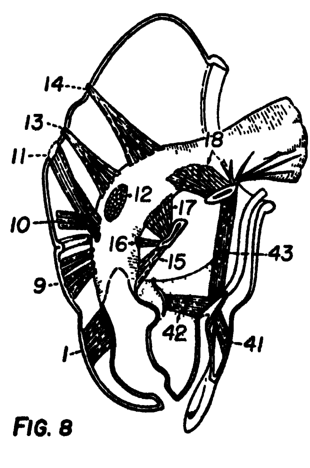


FIG. 8

PLATE LXIX

FIG. 9. Anterior view of muscles and attachment of right maxilla to epicranium. Retracted position.

FIG. 10. Outer muscles of right maxilla.

FIG. 11. Detailed view of intracranial muscles of right maxilla.

FIG. 12. Inner muscles of right maxilla.

FIG. 13. Intermediate and palpal muscles of right maxilla.

FIG. 14. Inner muscles of labium.

FIG. 15. Outer muscles of labium.

PLATE LXIX

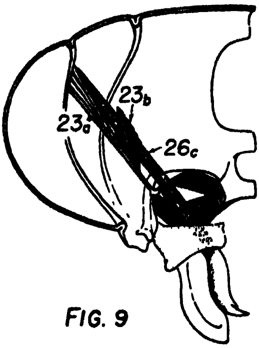


FIG. 9

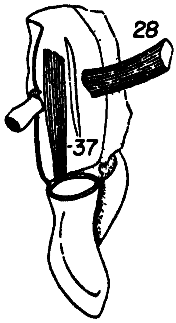


FIG. 10

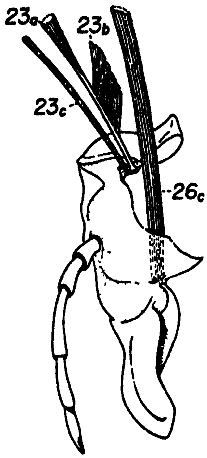


FIG. 11

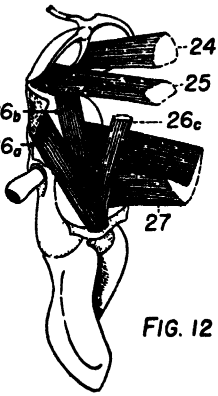


FIG. 12

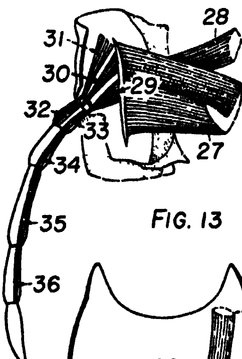


FIG. 13

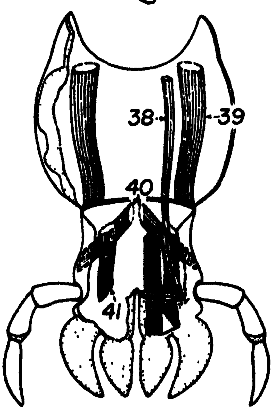


FIG. 14

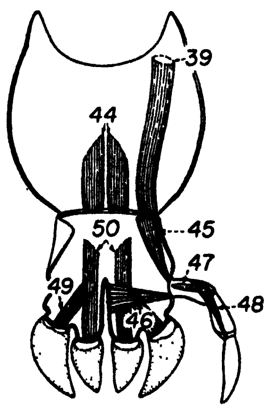


FIG. 15

PART 2—THE THORACIC MUSCULATURE

Under this heading are included the neck muscles as well as the muscles of the three thoracic somites. This inclusion is admittedly an arbitrary one, for no study of adult musculature can indicate which muscles or parts of muscles belong to the head, and which to the prothorax.

The neck of the Carolina mantis is a very flexible body region which permits the insect to turn its head into surprisingly many positions. The skeleton of the neck has two pairs of articulatory points, the anterior edges of the anterior lateral cervical sclerites (see section I, Plate XI, figures 7 and 10), and the upper points of the posterior lateral cervical sclerites. The anterior articulatory points press upon the condyles of the postoccipital sclerite (poc c, figure 1), and the posterior points upon the anterior margins of the prothoracic prepleurites. In addition to these four points of movement, two lines of flexure, which crease the posterior lateral cervical sclerites, form angles which extend and retract the skeleton. These features, with the cervical musculature, enable the mantis to twist the posterior rim of the cranium by quarter turns, or to shorten or lengthen one side of the neck.

The muscles involved in these movements are:

1. The lateral dorsal rotator of the head (figure 3); a three-part muscle extending from the central part of the anterior lateral cervical sclerite, 1a, from the mid-upper edge of the same sclerite, 1b, from the lower edge of the anterior rim of the prothoracic tergum, 1c, to the membrane near the dorsolateral portion of the postoccipital sclerite.
2. The protractor of the posterior lateral cervical sclerite (figures 2 and 3); a strong muscle extending from the anteromesal region of the prothoracic tergum to the lateroposterior portion of the posterior lateral cervical sclerite. This muscle pulls the cervical sclerite forward, enlarging the angle of the line of flexure and, thereby, elongating the neck.
3. The retractor of the anterior lateral cervical sclerite (figures 2 and 3); a large, flat muscle extending from the anteromesal area of the prothoracic tergum to the center of the anterior lateral cervical sclerite. This muscle is the antagonist of 2. When it contracts it closes the angle of the flexure of the posterior lateral cervical sclerite, thereby shortening the neck. However, if the protractor, 2, contracts first, the retractor merely completes the opening of the angle of the line of flexure.
4. The lateral rotator of the head (figure 2); a long, slender muscle extending from the tendon of the tergal adductor of the prothoracic coxa to the upper anterior edge of the anterior lateral cervical sclerite. This muscle might close the angle of the posterior lateral cervical sclerite, and turn the head laterally, but its slenderness indicates it plays a very minor role in the movements of the neck.

5. The median dorsal rotator of the head (figures 1 and 2); a slender muscle extending from the long tendon of the membrane near the pretergite of the mesothoracic tergum to the tendon of the dorsal cervical sclerite.
6. The lateral ventral rotator of the head (figure 2); a flat muscle extending from the posterior dorsolateral region of the neck skeleton to the membrane near the postoccipital condyle. This muscle cannot perform a ventral rotation of the head by itself, for its basal point is not even sclerotized. However, if the median dorsal rotator, 5, pulls upon the tendon of the dorsal cervical sclerite, yet permits itself to be stretched as the head is turned ventrally, the dorsal wall of the neck is held taut and the lateral ventral rotator is enabled to effect a pull.
7. The lateral dorsal rotator of the head (figure 1); a two-part muscle extending from the tendon of the membrane near the pretergite of the mesothoracic tergum, 7a, from the anteromesal region of the prothoracic tergum 7b, to the membrane adjacent to the dorsolateral portion of the postoccipital sclerite.
8. The ventral rotator of the head (figure 1); a long, strong muscle extending from the tendon of the prothoracic furcal apophyses to the ventral process of the postoccipital sclerite.

The above interpretations of the neck muscles are interpretations of the primary individual functions. No doubt these neck muscles do not function to any great extent as individuals, but as members of groups. There are five functional groups in the neck of the Carolina mantis, protractors, retractors, lateral rotators, dorsal and ventral rotators.

In the protractor group both protractors of the posterior lateral cervical sclerites pull forward the lower part of the neck. This pull widens the angles of the lines of flexure, creasing the posterior lateral cervical sclerites, and when these angles are obtuse the muscles 3 complete the protraction.

The retraction of the neck is effected by the combined pull of muscles 7 and 8, or, with 4 and 5 aiding the pair 7. The retractors, 3, of the anterior lateral cervical sclerites start the shortening of the neck by closing the angles of the lines of flexure of the posterior lateral cervical sclerites.

A lateral rotation of the head to the right may be started by a contraction of 3, which would fold the right posterior lateral cervical sclerite; then, 7 and 8, or 5 or 6, or both groups together, would turn the head to the right. Similar actions of the left-side members of these pairs of muscles would turn the head to the left.

A dorsal rotation of the head, from any angle between the neck sclerites, may be produced by the contraction of the pair 7, or with the aid of the pairs 5 and 1. The opposite movement, the ventral

rotation of the head, may be produced by the contraction of the pair 8, or with the aid of the pair 6.

These group functions are not performed with "smart" military precision, as the above descriptions might imply. The Carolina mantis is a leisurely sort of insect. It may be an awkward one, but it does try to cover its ungainliness with a quiet, slow dignity. When it turns its head it usually does so slowly, as the functions of the muscles blend in protraction, rotation, and retraction by varying intensities of contraction.

THE PROTHORACIC MUSCLES

In addition to the neck muscles lying within the prothorax proper, there are three principal groups of muscles which act upon the tergum, pleura, and sternum of this somite. Two groups are in the supracoxal region, and one group in the posterior region. Most of the supracoxal muscles are basal leg muscles, for only three pairs of small muscles act upon the tergum and pleura.

9. The tergal adductor of the coxa (figures 4 and 5); a large three-part muscle extending from the mesal region of the tergum, anterior to the supracoxal inflection, 9a, posterior to the inflection, 9b, and 9c, to the tendon of the pleurellite.

In *Dissosteira carolina* Snodgrass found the homologue of this mantid muscle to be a single band with a promotion function. In the mantis only 9a can impart any promotion, for the other two members are attached too far back on the tergum, and it is very probable 9a merely aids in the adduction of the coxa.

This adduction is one of the important movements in feeding. If the mantis catches an insect in its right foreleg, the predator turns the coxal base not quite a quarter-turn clockwise; then, it brings the coxa forward so that the distal portion points ahead and away to the left of its body. The combination of this rotation and promotion places the tibiofemoral joint, the point near which the victim is usually held, into a convenient position for the jaws of the mantis. The turning is performed by the muscles 12, 13, 14, and 17; the promotion is effected by 19a and 19b.

10. The tergal remotor of the coxa (figures 4, 5, and 9); a big two-part muscle extending from the midlateral region of the tergum to the tendon of the membrane near the posterior lateral portion of the basal coxal rim.
11. The anterior sternal rotator of the coxa (figures 5, 6, 7); a small, flat muscle extending from the median process of the furcasternite to the anterior portion of the basal coxal rim.

12. The posterior sternal rotator of the coxa (figures 5 and 9); a short, stout muscle extending from the outer basal surface of the furcal apophyses to the tendon of the membrane near the lateral portion of the basal coxal rim.
13. The accessory tergal remotor of the coxa (figure 5); a long, flaring, flat band extending from the midlateral region of the tergum to the tendon of the membrane near the lateral portion of the basal coxal rim.

This muscle probably corresponds to Snodgrass' "67—the second posterior rotator of the coxa" of *Dissosteira*. In the elongation of the Carolina mantis prothorax this muscle lost its basal attachment on the spinal process of the spinasternite, and became attached to the tergum.

14. The posterior abductor of the coxa (figure 5); a short, flat muscle extending from the lateral region of the tergum behind the supracoxal inflection to the tendon of the membrane near the lateral portion of the basal coxal rim.
15. The intermediate abductor of the coxa (figures 5 and 9); a short, flat, fan-shaped muscle extending from the lateral region of the tergum behind the supracoxal inflection to the peak of the lateral portion of the basal coxal rim.
16. The anterior abductor of the coxa (figure 5); a short, slender band extending from the lateral region of the tergum behind the supracoxal inflection to the peak of the lateral portion of the basal coxal rim.
17. The abductor-rotator of the coxa (figures 4 and 5); a long, flaring muscle extending from the upper lateral region of the tergum to the peak of the lateral portion of the basal coxal rim. The action of this muscle is a combined posterior rotation and abduction, with the rotation probably stronger than the abduction.

These muscles, 14, 15, 16, and 17, belong to the "M group" in Snodgrass' generalized plan of the basal coxal musculature.

18. The sternal adductor of the coxa (figure 6); a wide, flat band extending from the lower surface of the furcal apophysis to the mesal portion of the basal coxal rim.
19. The promotor of the coxa (figures 4 and 5); a strong, two-part muscle extending from the anterior portion of the prepleurite and the anterolateral part of the tergum before the supracoxal inflection, 19a, and from the posterior part of the prepleurite, 19b, to the tendon of the membrane near the anterior portion of the basal coxal rim.

These basal muscles of the coxa have six cardinal group functions, promotion, remotion, adduction, abduction, anterior rotation, and posterior rotation. In the promotion of the coxa, muscle 19 plays the important role; it is this muscle which extends the foreleg so rapidly. The antagonists effecting the remotion of the coxa are 10, 11, and 13. In the adduction the large three-part 9 is the impor-

tant muscle, though it is aided to some degree by muscle 18. The antagonistic abduction is performed by any combined pull of 14, 15, 16, or 17. As already noted, 17 also rotates the coxa posteriorly, though 12 is the primary posterior rotator. 12 is opposed by the anterior rotator 11. In the movements of the coxa all of these functions blend into one another imperceptibly by varying intensities of contraction.

20. The tergopleurellar muscle of the prothorax (figures 6, 8, and 9); a short, but stout, two-part muscle extending from the lateral part of the tergum behind the supracoxal inflection to the tip of the posterior sclerites of the pleurellar arch. Just what the significance and function of this muscle may be is difficult to determine from this study.
21. The tergopleural muscle of the prothorax (figure 6); a slender muscle extending from the lateral region of the tergum behind the supracoxal inflection to the tip of the pleural apophysis. This muscle has little function. It is serially homologous to the second tergopleural muscles of the mesothorax and metathorax (51, 88, figures 29 and 30).
22. The sternopleural muscle of the prothorax (figure 6); a tensor muscle composed of very short fibers holding the pleural apophysis close to the furcal apophysis.

Within the prothoracic leg are the following muscles:

23. The extensor of the femorella (figures 7 and 15); a complex muscle which pulls the well-developed extensor tendon of the membrane near the posterior portion of the basal rim of the femorella from five points: a, the posterior wall of the coxa; b, the pleurellar infolding; c, d, and e, the upper lateral region of the tergum posterior to the supracoxal inflection. This muscle is an odd combination of numerous short bundles, which gives the muscle a wide area of attachment upon the coxal wall, and four long bands. Probably the short bundles enable the muscle to extend the femorella and femur with rapidity, and the longer bands furnish additional strength.
24. The median accessory extensor of the femorella (figures 11 and 20); a slender muscle extending from the median distal region of the coxa to a small tendon of the membrane near the median portion of the basal femorellar rim, just posterior to the median coxofemorellar articulation.
25. The lateral accessory extensor of the femorella (figures 11 and 20); a slender muscle extending from the posterior distal region of the coxa to a small tendon of the membrane near the lateral portion of the basal femorellar rim. These accessory extensors are practically vestigial muscles in the prothoracic leg, since the median extensor has become such a highly developed contractile organ. In the other legs the median and lateral accessory extensors still play an important role.
26. The coxal flexor of the femorella (figures 11, 12, 15, and 19); a long, strong muscle extending from the anterior wall of the coxa to the well-developed tendon of the membrane near the anterior portion of the basal femorellar rim.

27. The lateral accessory flexor of the femorella (figures 11, 15, and 19); a wide, flat muscle extending from the distal lateroposterior region of the coxa to a wide tendon of the membrane above the anterior portion of the basal femorellar rim. In the other legs, the mesothoracic and metathoracic, this muscle is as well developed as the median flexor. In the twisting of the foreleg for a sagittal movement, and the elongation of the coxa, the median flexor became developed as the chief flexor muscle, while the lateral flexor became reduced to serve as an alleviator of the strain of the chief flexor placed upon the median coxofemorellar articulation.
28. The remotor of the femur (figure 15); a short, flat, two-piece muscle extending from the ventral wall of the femorella to the lateral portion of the basal rim of the femur. It is odd that a muscle so well developed as this one should have so little function, for there is but little movement possible between the femur and femorella.
29. The extensor of the tibia (figures 10, 13, and 18); a long, narrow muscle composed of numerous short bundles extending from the dorsal wall of the femur to the long, flat tendon of the membrane near the dorsal portion of the basal tibial rim.
30. The median accessory extensor of the tibia (figure 18); a vestigial muscle extending from the dorsal wall of the femoral base to the long, slender tendon of the membrane near the dorsal portion of the basal tibial rim.
31. The flexor of the tibia (figures 10, 13, and 18); a powerful muscle of complex structure extending from the ventral and side walls of the femur, 31a, and from the median wall of the femorella, 31b, to the highly-developed flat tendon of the membrane near the ventral portion of the basal tibial rim. This is the muscle which makes the prothoracic tibia and femur such an uncompromising vise mechanism.
32. The extensor of the tarsus (figures 14 and 16); a long, slender, fan-shaped muscle extending from the median wall of the tibia to the tendon of the membrane (see figure 17) near the dorsal portion of the basal tarsal rim.
33. The flexor of the tarsus (figures 14 and 16); a long, slender muscle extending from the median and ventral walls of the tibia to the tendon of the membrane near the ventral portion of the basal tarsal rim.
34. The flexor of the claws (figures 13, 14, 16, 17, 18, 21); a three-part muscle extending from the lateroventral wall of the tibia (34a), from the dorsal wall of the tibial base (34b), and from the laterodorsal area of the femoral base (34c), to the long, slender tendon of the claw mechanism. If the use of a good clearing solution to render the tarsus transparent, and careful observation with a new Spencer research microscope may be trusted, there are no intrinsic tarsal muscles in the Carolina mantis.

In the posterior region of the prothorax are the muscles which operate the hemicylinder formed by the skeleton of this thoracic segment in a manner simulating that of a boom on a steam shovel. Also in this region are the muscles of the first thoracic spiracle.

35. The tergal levator of the prothorax (figures 22 and 23); a wide, flat muscle extending from the tendon of the membrane before the pretergite of the mesothoracic tergum to the posterior lateral wall of the prothoracic tergum.
36. The sternal levator of the prothorax (figures 22, 23, 25); a stout muscle extending from the tendon of the membrane before the pretergital apophysis of the mesothoracic tergum to the posterior lateral region of the prothoracic sternum.
37. The tergal protractor of the prothorax (figures 22 and 23); a thick, short muscle extending from the tip of the pretergital apophysis of the mesothoracic tergum to the posterior median area of the prothoracic tergum.
38. The sternal protractor of the prothorax (figures 22 and 25); a strong muscle extending from the tip of the pretergital apophysis of the mesothoracic tergum to the posterior lateral region of the prothoracic sternum.

The levitation of the prothorax is produced by the combined action of the sternal levators, the tergal levators, and the sternal protractors. The sternal levators probably begin the lifting since they are in advantageous positions when the prothorax is low; however, the sternal protractors may also start the levitation. Obviously these are made by the pairs of these muscles functioning as units, for unequal contraction of the pairs turns the prothorax to the side of more intense contraction, except in the case of the sternal protractor. If the right protractor contracts more intensely than the other muscles of this region, the prothorax is turned to the left.

The antagonistic movement to levitation, the depression of the prothorax, is produced partially by the action of the tergal protractors, partially by the secondary ventral longitudinal muscles of the mesothorax, and partially by the weight of the prothorax, its legs, and the head.

39. The sternal spiracular muscle (figure 22); a vestigial muscle tying the membrane below the first thoracic spiracle to the posterior lateral region of the prothoracic sternum.
40. The occlusor of the first thoracic spiracle (figure 14, Plate LXXVIII); a flat band extending from the lower anterior portion of the peritreme to the straplike occlusor process.
41. The dilator of the first thoracic spiracle (figure 14, Plate LXXVIII); a flaring band extending from the lower portion of the peritreme to the anterior lip of the spiracle.

THE PTEROTHORACIC MUSCLES

From a study of dissections of fixed specimens of the adult Carolina mantis it is not possible to separate definitely the prothoracic from the mesothoracic muscles. There are muscles extending from

the true intersegmental region to parts of the prothoracic skeleton, muscles extending from the same intersegmental region to parts of the mesothoracic skeleton, and there are muscles extending between parts of the prothoracic and parts of the mesothoracic skeleton. In this study I am arbitrarily designating some of these muscles as prothoracic, others as mesothoracic, but acknowledge that only careful observations of an ontogenetic study will furnish evidence of segmental identities.

42. The primary ventral longitudinal muscles of the mesothorax (figures 24, 26); a pair of slender, ribbonlike muscles extending from the spinal apophysis on the prothoracic sternum to the spinal apophysis on the metathoracic sternum. These muscles are too weak to play any important role.
43. The median secondary ventral longitudinal muscles of the mesothorax (figures 24, 26); a pair of stout muscles extending from the long tendons of the furcal apophyses of the mesothoracic sternum to the base of the spinal apophysis on the prothoracic sternum.
44. The lateral secondary ventral longitudinal muscles of the mesothorax (figures 24, 26); a pair of strong muscles extending from the tendons of the furcal apophyses of the mesothoracic sternum to the posterior lateral areas of the prothoracic sternum. These secondary ventral longitudinal muscles of the mesothorax are the antagonists to the sternal protractors (38) of the prothorax. They also aid in turning the prothorax from side to side.
45. The sternal retractor of the first epipleurite of the mesothorax (figures 22, 25, 26); a stout muscle extending from the side of the spinal apophysis on the prothoracic sternum to the lower portion of the first epipleurite.
46. The posterior tergal retractor of the first epipleurite of the mesothorax (figures 22, 23, 26); a twisted muscle extending from the pretergite of the mesothoracic tergum (figure 23) to the lower portion of the first epipleurite.
47. The anterior tergal retractor of the first epipleurite of the mesothorax (figures 22, 23, 26); a short, thick muscle extending from the intersegmental ridge to the upper part of the first epipleurite. The contraction of these retractors serves to hold the epipleurite as a basal point for the fourth branch of the extensor of the femorella of the mesothoracic leg.
48. The tergosternal muscle of the mesothorax (figure 27); a long, slender muscle extending from the median area of the mesothoracic tergum to the midlateral part of the mesothoracic sternum. The function of this muscle is the compression of the mesothorax, but this muscle of the Carolina mantis is too weak for such work.
49. The flexor of the mesothoracic wing (figures 29 and 31); a wide, flat band extending from the upper portion of the pleural infolding to the inner part of the dorsal sclerite of the vannal axillary.
50. The anterior tergopleural muscle of the mesothorax (figure 29); a wide, flat band extending from the pleural infolding to the midlateral margin

of the tergum. This muscle aids in the deflection of the posterior basal area of the wing. It also aids in the arching of the tergum.

51. The posterior tergopleural muscle of the mesothorax (figures 29 and 31); a long, slender muscle extending from the upper portion of the pleural apophysis to the midlateral margin of the tergum. The action of this muscle is similar to that of the anterior tergopleural muscle.
52. The median dorsal oblique muscle of the mesothorax (figure 26); a strong muscle extending from the apophysis of the intersegmental ridge on the metathoracic tergum to the posterior median area of the mesothoracic tergum.
53. The lateral dorsal oblique muscle of the mesothorax (figures 27 and 29); a wide band extending from the lateral surface of the apophysis of the intersegmental ridge on the metathoracic tergum to the posterior lateral area of the mesothoracic tergum.
54. The intermediate dorsal oblique muscle of the mesothorax (figures 26 and 27); a flaring muscle extending from the tendon of the membrane before the pretergite of the metathoracic tergum to the posterior medial area of the mesothoracic tergum. These dorsal oblique muscles are primarily retractors when acting as paired units. If those of the right side only contract, the mesothorax is turned to the right.
55. The tergal protractor of the mesothorax (figure 26); a stout muscle extending from the tip of the apophysis of the intersegmental ridge on the metathoracic tergum to the furcal apophysis of the mesothoracic sternum. Though not the most efficient muscle for protraction, it does extend the mesothoracic sternum forward after the pterothorax has been arched.
56. The pleurosternal muscle of the mesothorax (figures 24, 26, 27); a short, thick muscle extending from the lower portion of the pleural apophysis to the furcal apophysis of the mesothoracic sternum. This muscle is primarily a tensor between the pleurum and sternum.
57. The dilator of the second thoracic spiracle (figure 29); a thin, flaring muscle extending from the furcal apophysis of the mesothoracic sternum to the lower part of the peritreme. A fingerlike invagination of the membrane above the posterior portion of the basal coxal rim is attached to the middle of this spiracular muscle. Whatever the structural significance of this feature may be, we shall leave it to the mantis for explanation.
58. The occlusor of the second thoracic spiracle (figure 16, Plate LXXVIII); a short, fan-shaped muscle pulling the lower portions of the spiracular lips against the lower rim of the peritreme.

These muscles are muscles that work upon the trunk portion of the mesothoracic skeleton. The following muscles, though affecting the trunk walls, are essentially the basal leg muscles of the mesothorax:

60. The sternal productor of the pleurellite (figure 24); a flat, flaring band extending from the infolding separating the mesothoracic prepleurite from the basisternite to the anterior border of the pleurellite.
61. The epipleuritellar productor of the pleurellite (figures 26, 27, 29); a long, slender muscle extending from the infolding of the first epipleurite to the anterior border of the pleurellite.

62. The tergal abductor of the pleurellite (figure 26); a large twinned muscle extending from the anterior median area of the tergum to the tendon of the tip of the pleurellite.
63. The accessory promotor of the coxa (figure 31); a long, slender band extending from the first epipleurite to the anterior portion of the basal coxal rim.
64. The promotor of the coxa (figure 31); a large, three-part muscle extending from the anterior area of the prepleurite (a), from the central part of the first epipleurite (b), from the pleural infolding (c), to the stout tendon of the membrane near the coxal rim.
65. The remotor of the coxa (figures 26, 27, 31); a large, two-piece muscle extending from the central area of the tergum to the strong tendon of the membrane near the posterior lateral rim of the coxa.
66. The anterior rotator of the coxa (figure 24); a short, stout muscle extending from the lower anterior position of the furcal arch of the mesothoracic sternum to the anterior median portion of the basal coxal rim.
67. The posterior rotator of the coxa (figure 24); a slender band extending from the side of the spinal apophysis on the metathoracic sternum to the posterior lateral portion of the basal coxal rim.
68. The accessory remotor of the coxa (figure 24); a short, flat band extending from the tip of the furcal apophysis to the posterior portion of the basal coxal rim.
69. The abductor of the coxa (figure 24); a short, stout muscle extending from the tip of the furcal apophysis to the lateral portion of the basal coxal rim.
70. The depressor of the mesothoracic wing (figures 29, 31); a wide, flat band extending from the lateral portion of the basal coxal rim to the third epipleurite of the mesothorax.
71. The extensor of the femorella (figures 27, 29, 33, 35); a complex four-piece muscle extending from the median basal region of the mesothoracic coxa (a), from the lower surface of the furcal apophysis (b), the central area of the tergum (c), the upper part of the first epipleurite (d), to the highly developed tendon of the membrane near the median portion of the femorellar basal rim.

The following muscles are wholly intrinsic muscles of the mesothoracic leg:

72. The anterior accessory extensor of the femorella (figures 33 and 34); a strong, two-piece muscle extending from the anterior basal region of the coxa to the tendon of the membrane near the anterior mesal portion of the femorellar base.
73. The posterior accessory extensor of the femorella (figures 33 and 34); a stout muscle extending from the posterior basal region of the coxa to the tendon of the membrane near the posterior medial portion of the femorellar base.
74. The anterior flexor of the femorella (figures 34 and 35); a strong, two-piece muscle extending from the basal anterior area of the coxa to the tendon of the membrane near the anterior lateral portion of the femorellar base.
75. The posterior flexor of the femorella (figures 34 and 35); a strong, two-

piece muscle extending from the basal lateral area of the coxa to the tendon of the membrane near the posterior lateral portion of the femorellar base.

From the condition of the extensor and flexor muscles of the femorella of the mesothoracic and metathoracic legs it is apparent that the basic plan of the musculature of the mantis coxa consists of two flexors nearly equal in size, and each composed of two bands, and three flexors of unequal proportions. The musculature of the prothoracic coxa is a modification of this basic plan. The anterior flexor has been greatly developed, and the posterior flexor reduced; the median extensor has been well developed, but the accessory extensors are mere vestiges.

76. The femorellar reductor of the femur (figure 36); a short, stout muscle extending from the ventral wall of the femorella to the tendon of the posterior portion of the basal femoral rim. Like its homologue in the prothoracic leg, this muscle of the mesothoracic leg has practically no function, for there is but little movement between the femorella and femur.
77. The extensor of the tibia (figure 36); a long muscle composed of numerous short bundles extending from the dorsal wall of the femur (77a), and from the anterior surface of the femorella (77b—not drawn) to the long, flat tendon of the membrane near the dorsal portion of the tibial base.
78. The accessory extensor of the tibia (not figured); looks very much like 30b of the prothoracic leg (see figure 18); a vestigial muscle extending from the dorsal basal region of the femur to the long, slender tendon of the membrane near the dorsal portion of the tibial base.
79. The flexor of the tibia (figures 36, 38); a long, complex muscle of numerous short bundles and long bands, extending from the ventral and lateral walls of the femur to the large, flat tendon of the membrane near the ventral portion of the tibial base.
80. The extensor of the tarsus (figures 37 and 40); a long, slender muscle extending from the posterior wall of the tibia to the tendon of the membrane near the dorsal portion of the tarsal base (see figure 39).
81. The flexor of the tarsus (figures 37 and 40); a short, flat muscle extending from the distal ventral region of the tibia to the tendon of the membrane of the tarsal base.
82. The unguiflexor muscle (figures 42, 40, 37, 38, 36); a three-piece muscle extending from the anterior ventral region of the tibia (82a), the dorsal wall of the tibial base (82b), the posterior basal region of the femur (82c—see figure 36), to the long tendon of the claw retractor mechanism.

In the metathorax the following muscles work upon the skeleton of the semite:

83. The sternal retractor of the metathorax (figure 24); a slender, flat band extending from the side of the spinal apophysis on the metathoracic sternum to the anterior portion of the infolding separating the metathoracic prepleurite from the basisternite. This muscle is probably serially

homologous to 45 of the mesothorax, differing from that muscle in being reduced, and having shifted its apex from the first epipleurite of the metathorax to the sternal region. The reduced condition indicates this muscle has only a minor function.

84. The lateral secondary ventral longitudinal muscle of the metathorax (figures 24 and 26); a big muscle extending from the long tendon of the furcal apophysis of the metathoracic sternum to the posterior surface of the furcal apophysis of the mesothoracic sternum.
85. The tergal retractor of the first epipleurite of the metathorax (figure 26); a strong muscle extending from the apophysis of the intersegmental ridge of the metathoracic tergum to the lower portion of the first epipleurite.
86. The flexor of the metathoracic wing (figures 30 and 32); a short, flat muscle extending from the upper portion of the pleural infolding to the inner surface of the dorsal sclerite of the vannal axillary.
87. The anterior tergopleural muscle of the metathorax (figures 28 and 30); a wide, flat band extending from the upper portion of the pleural infolding to the midlateral margin of the tergum. This muscle deflects the posterior basal area of the metathoracic wing, and also aids in arching the tergum.
88. The posterior tergopleural muscle of the metathorax (figures 28 and 30); a slender, flat muscle extending from the upper surface of the pleural apophysis to the midlateral margin of the tergum.
89. The median dorsal oblique muscle of the metathorax (figure 26); a strong, flaring muscle extending from the posterior median area of the metathoracic tergum to the tendon of the membrane near the anterior border of the first abdominal tergum.
90. The lateral dorsal oblique muscle of the metathorax (figures 26 and 28); a wide, flat band extending from the posterior median region of the metathoracic tergum to the anterior lateral region of the first abdominal tergum. These dorsal oblique muscles of the metathorax are retractors of the first abdominal tergum.
91. The lateral depressor of the first abdominal tergum (figure 26); a flaring muscle extending from the furcal apophysis of the metathoracic sternum to the lateral margin of the first abdominal tergum. This muscle is probably serially homologous to 55 of the mesothorax.
92. The pleurosternal muscle of the metathorax (figures 24, 26, 28); a short, thick muscle extending from the lower surface of the pleural apophysis to the upper surface of the furcal apophysis. This is a tensor muscle.

About the leg base of the metathorax are these muscles:

93. The sternal productor of the pleurellite (figures 24 and 32); a flat, flaring band extending from the lower portions of the prepleurite and basisternite to the anterior border of the pleurellite.
94. The epipleuritellar productor of the pleurellite (figures 28, 30, 32); a long, slender muscle extending from the lower portion of the infolding of the first epipleurite to the anterior border of the pleurellite.
95. The tergal abductor of the pleurellite (figures 26 and 32); a large three-part muscle extending from the anterior median area of the tergum to the strong tendon of the tip of the pleurellite.

96. The promotor of the coxa (figure 32); a strong, three-part muscle extending from the midanterior region of the prepleurite (a), the central area of the first epipleurite (b), the pleural ridge (c), to the large tendon of the membrane near the anterior lateral portion of the coxal base.
97. The remotor of the coxa (figures 26, 28, 32); a big muscle extending from the median area of the tergum to the large tendon of the membrane near the posterior lateral portion of the basal coxal rim.
98. The anterior rotator of the coxa (figure 24); a flat muscle extending from the anterior part of the furcal arch to the anterior portion of the basal coxal rim.
99. The posterior rotator of the coxa (figure 24); a wide, flat muscle extending from the tip of the furcal apophysis to the posterior portion of the basal rim of the coxa.
100. The abductor of the coxa (figure 24); a twisted muscle extending from the tip of the furcal apophysis to the lateral portion of the basal coxal rim.
101. The adductor of the coxa (figure 24); a flat band extending from the furcal apophysis to the posterior medial portion of the coxal base.
102. The depressor of the metathoracic wing (figures 28, 30, 32); a wide, flat muscle extending from the lateral portion of the basal coxal rim to the third epipleurite of the metathorax.
103. The chief extensor of the femorella (figures 41, 26, 28, 30); a big, four-part muscle extending from the median basal area of the coxa (a), the lower surface of the furcal apophysis (b), the anterior median area of the tergum (c), and the upper part of the first epipleurite (d), to the highly developed tendon of the membrane near the median portion of the femorellar base.

The pterothoracic muscles cannot be dismissed after merely indicating their primary individual functions in their names, especially those of the Carolina mantis. They form a peculiar modification of the basic thoracic musculature. The most startling fact in this modification is the absence of the primary dorsal longitudinal muscles in both the mesothorax and metathorax. This absence makes the dissector wonder how such an insect moves its wings for flight, and the mantis does flutter, if not fly.

Since the living insect is able to use its wings, it must be that muscles other than the primary flight muscles of the generalized pterygotan perform the arching of the tergum necessary for the downstroke of the hind wings. It is probable that the following contractions arch the metathoracic tergum of the Carolina mantis; the tergal retractors of the first epipleurites (85) hold those two sclerites so they serve as relatively firm bases for the epipleuritellar branches of the femorellar extensors (103d), and when these muscles contract they pull back upon the first epipleurites, which stress is transmitted through the tergal retractors (85), which act as tensors, to the anterior border of the metathoracic tergum. When this

border is pulled backward, the stress is relieved by an arching of the tergum over the wing fulcra, the uppermost points of the pleural infoldings. In this arching the anterior tergopleural muscles aid by pulling the posterior lateral regions of the tergum downward and forward.

The antagonistic function, the depression of the tergum which causes the upward stroke of the wings, may be produced by the tergal abductors of the pleurellites (95), the tergal branches of the femorellar extensors (103c), and the remotors of the coxae (97). In the more generalized thorax this depression of the tergum is performed by a pair of tergosternal muscles. Such muscles, though present in the mesothorax of the Carolina mantis, are not in the metathorax.

In comparing the condition of the musculature of the metathorax with that of the mesothorax, in the Carolina mantis, one is surprised in finding the musculature of the mesothorax more elaborate than that of the metathorax, in spite of the fact that the metathoracic legs are used to maintain the depending position so often assumed by the mantis. There is one more pair of epipleuritellar retractors in the mesothorax, and the sternal epipleuritellar retractors of the metathorax (83) have shifted their apices to the sides of the basisternite. It would seem that since the metathoracic wings are the flight wings, a more elaborate musculature about the first epipleurites would be necessary to compensate for the indirect manner of arching the tergum. Though the tergosternal muscles of the mesothorax are practically valueless, it would seem that since these muscles are present in the mesothorax they should be well-developed contractile organs in the metathorax. The Carolina mantis is indeed a peculiar animal.

The following muscles are intrinsic leg muscles of the metathorax:

104. The anterior accessory extensor of the femorella (figure 41); a muscle very similar in form and serially homologous to 72 of the mesothoracic leg.
105. The posterior accessory extensor of the femorella; similar in form and serially homologous to 73 of the mesothoracic leg.
106. The anterior flexor of the femorella (figure 41); serially homologous to 74.
107. The posterior flexor of the femorella (figure 41); serially homologous to 75.

By comparing figures 35 and 41, it may be seen that the coxal musculature of the mesothorax is very similar to that of the metathorax. Because of this fact, I have not drawn figures of the muscles of the telopodite of the metathoracic limb; however, this does not

mean I have not dissected this limb. The equivalents of the mesothoracic leg in the metathoracic are:

108. The reductor of the femorella; serially homologous to 76.
109. The extensor of the tibia; serially homologous to 77.
110. The accessory extensor of the tibia; serially homologous to 78.
111. The flexor of the tibia; serially homologous to 79.
112. The extensor of the tarsus; serially homologous to 80.
113. The flexor of the tarsus; serially homologous to 81.
114. The unguiflexor muscle; serially homologous to 82.

REFERENCES

For a good bibliography on the thorax see Snodgrass, R. E., "The Thoracic Mechanism of the Grasshopper, and its Antecedents," Smiths. Misc. Coll., vol. 82, No. 2, 1929.

PLATE LXX

FIG. 1. Neck muscles from median plane.
FIG. 2. Median muscles removed.
FIG. 3. Outer muscles of neck.

PLATE LXX

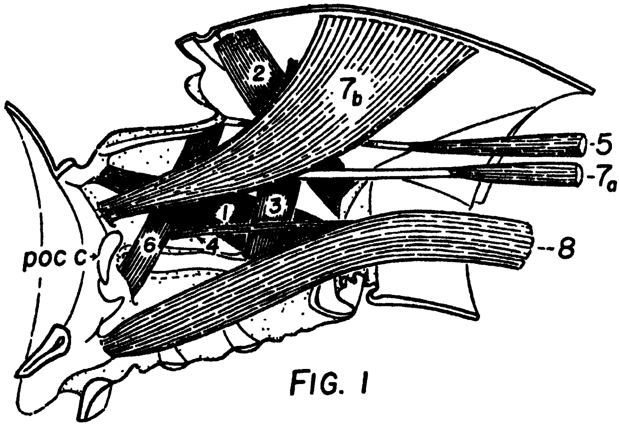


FIG. 1

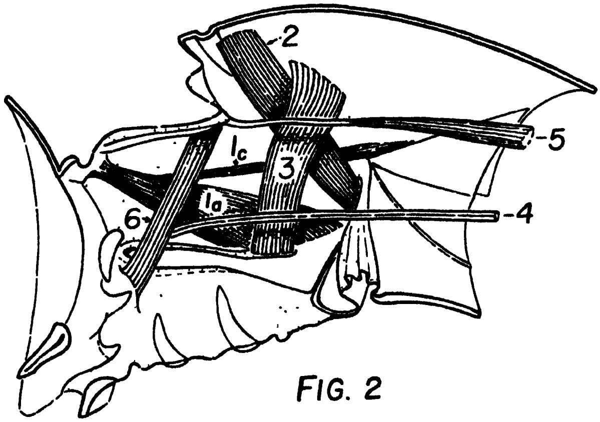


FIG. 2

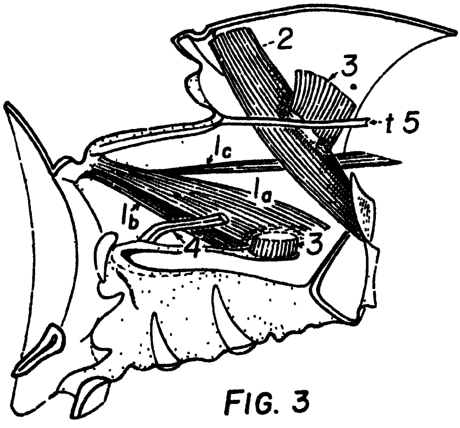


FIG. 3

PLATE LXXI

FIG. 4. Anterior prothoracic muscles from median plane.
FIG. 5. Basal muscles of right foreleg.
FIG. 6. Muscles above base of right foreleg from median plane.
FIG. 7. Median muscles removed from above dissection.
FIG. 8. Muscles posterior to tergal supracoxal inflection, from outer view.
FIG. 9. Outer muscles above foreleg base.

PLATE LXXI

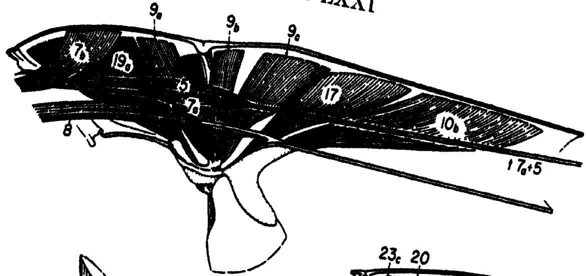


FIG 4

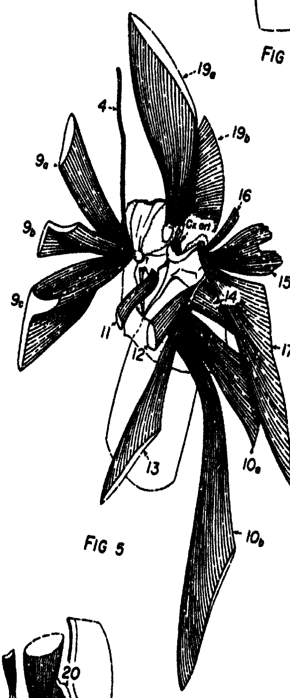


FIG 5

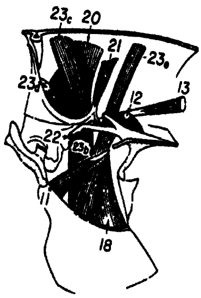


FIG 6

FIG 7

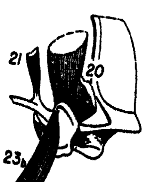


FIG. 8

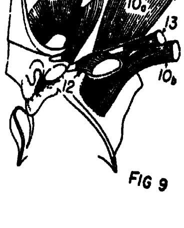
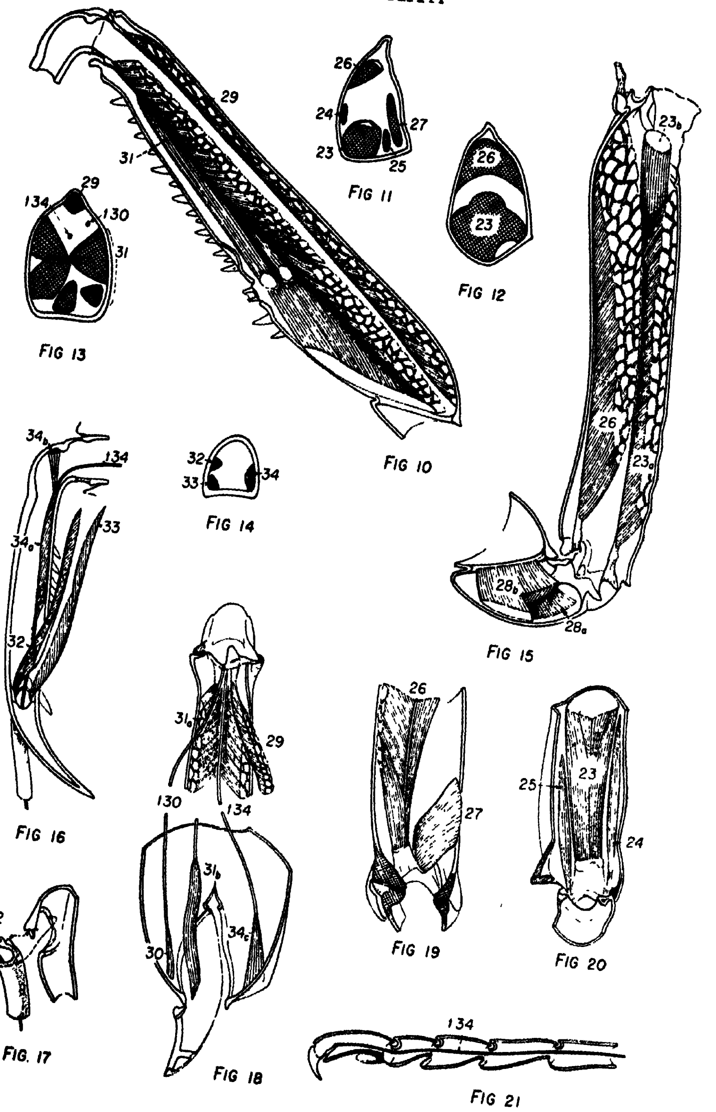


FIG 9

PLATE LXXII

FIG. 10. Muscles in right femur, side view.
FIG. 11. Cross section through distal part of right coxa.
FIG. 12. Cross section through basal part of right coxa.
FIG. 13. Cross section through middle of right femur.
FIG. 14. Cross section through distal portion of right tibia.
FIG. 15. Muscles in right coxa and femorella, side view.
FIG. 16. Muscles in right tibia from side view.
FIG. 17. Tendons and articulation of right tarsal base to tibia.
FIG. 18. Top view of muscles in right femur and femorella.
FIG. 19. Flexors of right femorella.
FIG. 20. Extensors of right femorella.
FIG. 21. Median section of right tarsus.

PLATE LXXII


29
31
FIG 10
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24
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FIG 11
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23
FIG 12
29
134
130
31
FIG 13
32
33
34
FIG 14
23b
26
23a
28b
28a
FIG 15
34b
134
33
34a
32
FIG 16
132
134
133
FIG. 17
31a
29
130
134
31b
34c
30
FIG 18
26
27
FIG 19
25
23
24
FIG 20
134
FIG 21

PLATE LXXIII

FIG. 22. Posterior prothoracic and anterior mesothoracic muscles from median plane.
FIG. 23. Dorsal muscles of these regions.
FIG. 24. Ventral muscles of mesothorax and metathorax.
FIG. 25. Ventral posterior prothoracic muscles.

PLATE LXXIII

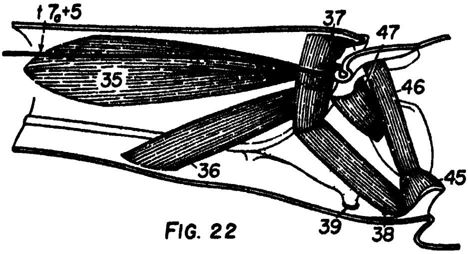

FIG. 22

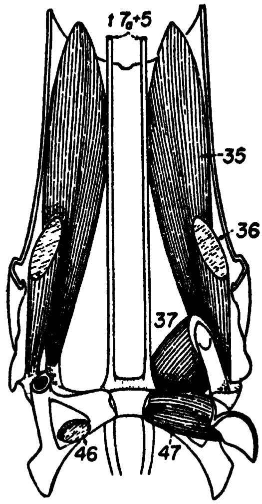

FIG. 23

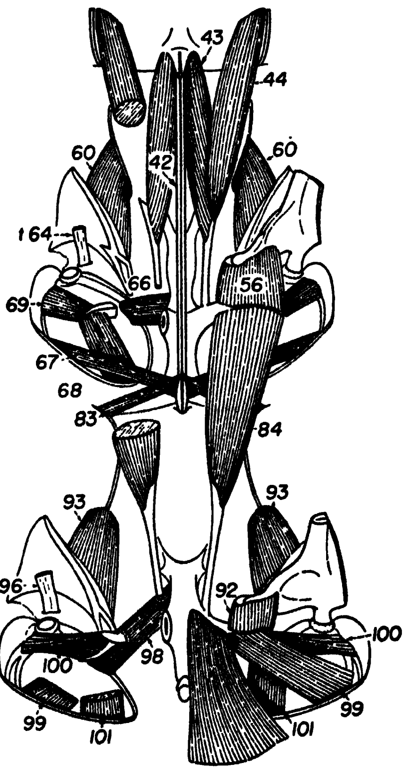

FIG. 24

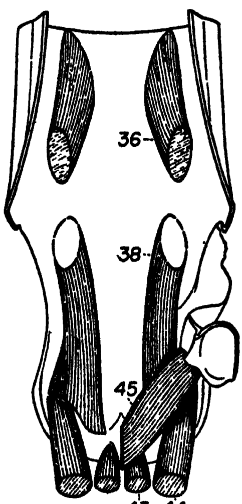

FIG. 25

PLATE LXXIV A

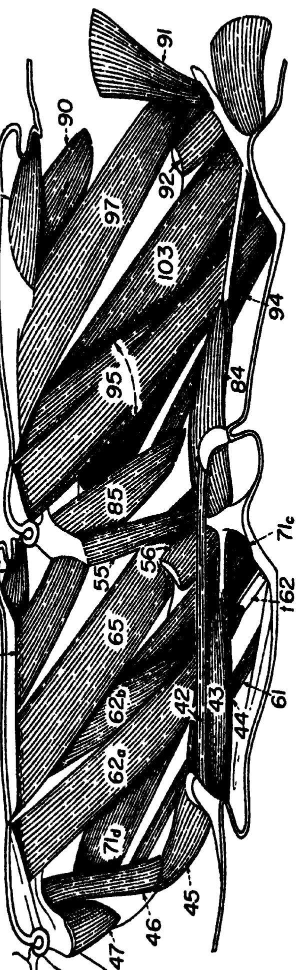

FIG. 26

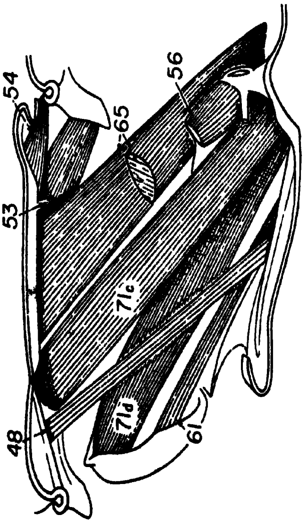

FIG. 27

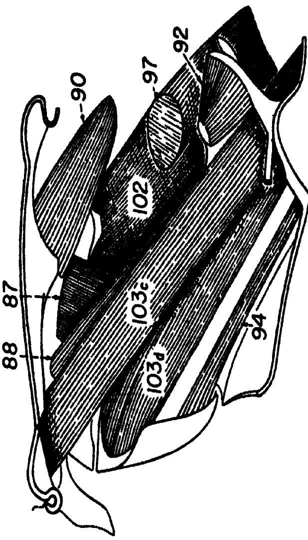

FIG. 28

FIG. 26. Mesothoracic and metathoracic muscles from median plane.
FIG. 27. Median mesothoracic muscles removed. FIG. 28. Median metathoracic muscles removed.

PLATE LXXIV B

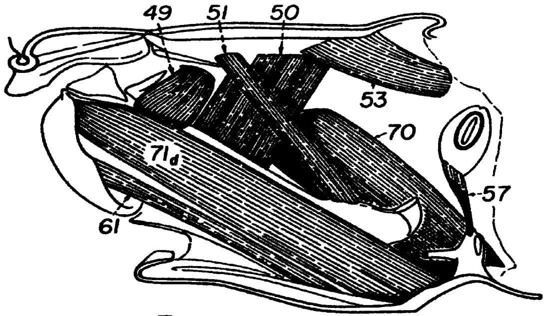

FIG. 29

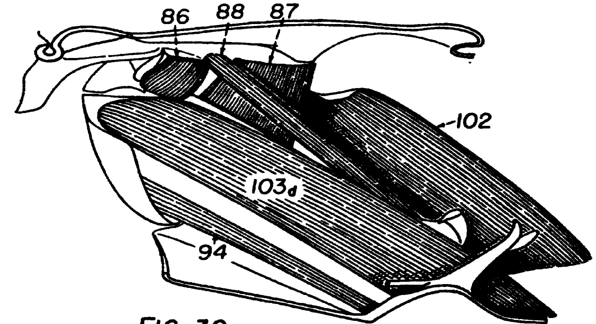

FIG. 30

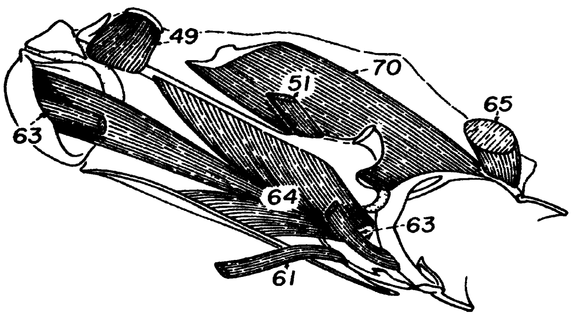

FIG. 31

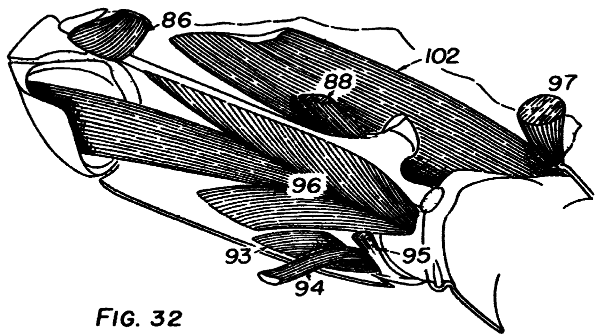

FIG. 32

FIG. 29. Third layer of mesothoracic muscles.
FIG 31. Outer muscles of mesothorax.

FIG. 30. Third layer of metathoracic muscles.
FIG. 32. Outer muscles of metathorax.

PLATE LXXV

FIG. 33. Extensors of right middle femorella.
FIG. 34. Flexors of right middle femorella.
FIG. 35. Sideview of femorellar muscles within right middle coxa.
FIG. 36. Sideview of muscles within right middle femur and femorella.
FIG. 37. Cross section through distal part of right middle tibia.
FIG. 38. Cross section through middle of right middle femur.
FIG. 39. Tendons and articulation of right middle tarsus to tibia.
FIG. 40. Sideview of muscles in right middle tibia.
FIG. 41. Sideview of muscles in right hind coxa.
FIG. 42. Median section of middle tarsus.

PLATE LXXV

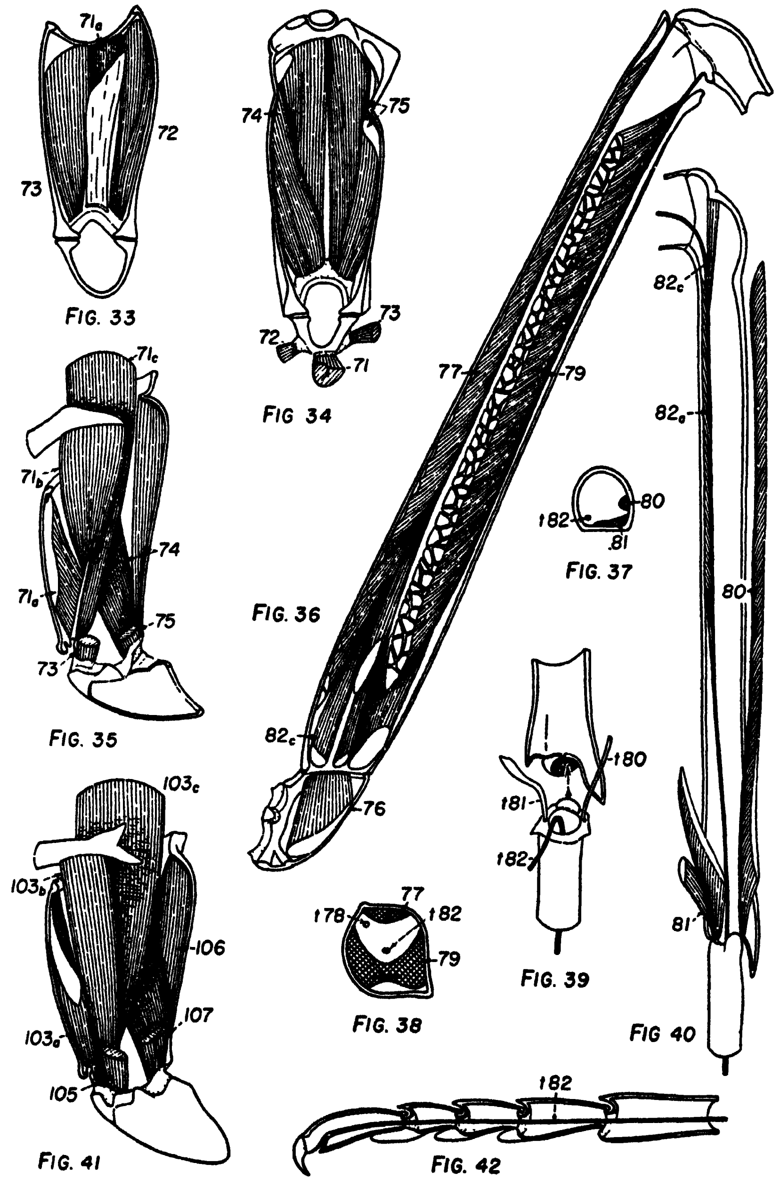

FIG. 33 FIG 34 FIG. 35 FIG. 36 FIG. 37 FIG. 38 FIG. 39 FIG 40 FIG. 41 FIG. 42

PART 3—THE ABDOMINAL MUSCULATURE

After studying for some time the cephalic and thoracic musculature of this insect, one tends to accept the notion unconsciously that the musculature occupies most of the space within the insect body. It is somewhat surprising to start dissecting the abdomen and find its musculature crowded closely against the skeletal walls. In this region the dissector is made to realize that the muscles associated with what might be termed the manufactory of the insect have functions different from those of the transportation and accumulating units. The muscles of the pregenital portion of the Carolina mantis abdomen indicate by their forms and attachments that respiration and support of the large hull are their main concerns.

The muscles of the first abdominal segment differ from those of the second and third segments, because the first tergum is functionally an anchorage of the abdomen to the thorax, and the first sternum is reduced to a functionless condition.

1. The longitudinal retractor of the second abdominal tergum (figure 4); a broad, flat sheet extending from the intersegmental region of the first tergum to the membrane before the second tergum.
2. The median oblique retractor of the second abdominal tergum (figures 2 and 4); a flat flaring muscle extending from the posterior median region of the first tergum to the membrane before the second tergum. In the succeeding segments the serial homologues of this muscle are functionally protractors.
3. The intermediate oblique retractor of the second abdominal tergum (figures 2 and 4); a short muscle extending from the posterior lateral region of the first tergum to the membrane before the paratergite of the second tergum. In the succeeding segments the serial homologues of this muscle are lateral retractors of the terga (see muscle 18 of figures 3 and 4).
4. The lateral oblique retractor of the second abdominal tergum (figures 2 and 4); a flaring muscle extending from the midlateral region of the first tergum to the membrane before the paratergite of the second tergum.
5. The flexor of the peritreme of the first abdominal spiracle (figure 2); a flat band extending from the anterior border of the paratergite of the second tergum to the lower anterior edge of the peritreme of the first spiracle. The serial homologues of this muscle in the succeeding segments are lateral sternal retractors of the terga (see muscle 20 of figures 3 and 4).
6. The retractor of the peritreme of the first abdominal spiracle (figure 2); a slender muscle extending from the anterior lateral area of the first tergum to the lower anterior rim of the peritreme of the first spiracle.
7. The dilator of the first abdominal spiracle (figure 17); a thin band extending from the anterior portion of the peritreme to the dilator process of the lower portion of the anterior spiracular lip.

8. The occlusor of the first abdominal spiracle (figure 17); a stout little muscle extending from the occlusor process of the lower portion of the posterior spiracular lip to the dilator process of the anterior lip.
9. The longitudinal retractor of the second abdominal sternum (figures 1 and 4); a flat, flaring sheet extending from the posterior surface of the furcal apophysis of the metathoracic sternum to the anterior border of the second abdominal sternum.
10. The oblique retractor of the second abdominal sternum (figures 1 and 4); a slender band extending from the posterior portion of the metathoracic sternum to the anterior lateral margin of the second abdominal sternum.

The muscles in the second abdominal segment are:

11. The longitudinal retractor of the third abdominal tergum (figure 4); a broad, flat sheet extending from the anterior region of the second tergum to the membrane before the third tergum.
12 The median protractor of the third abdominal tergum (figure 3); a flat, flaring muscle extending from the posterior median region of the second tergum to the membrane before the third tergum.
13. The lateral protractor of the third abdominal tergum (figure 3); a flat, flaring muscle extending from the posterior lateral region of the second tergum to the anterior edge of the paratergite of the third tergum.
14 The lateral oblique retractor of the third abdominal tergum (figures 3 and 4); a short, flat muscle extending from the posterior lateral region of the second tergum to the anterior edge of the paratergite of the third tergum
15. The anterior tergosternal muscle (figure 4); a cylindrical muscle extending from the midlateral region of the second tergum to the midlateral region of the second sternum
16. The posterior tergosternal muscle (figure 4); a slender, cylindrical muscle extending from the posterior lateral region of the second tergum to the posterior lateral region of the second sternum. These tergosternals, functioning as compressors, are the important respiratory muscles of the pregenital segments
17. The anterior lateral retractor of the second sternum (figure 4); a radiating group of bundles extending from the anterior lateral region of the second tergum to the membrane above the anterior lateral border of the second sternum. This group of bundles keeps the lateral membrane tucked inside the paratergite. It also aids in the compression of the segment for respiration.
18. The posterior lateral retractor of the second sternum (figures 3 and 4); a flat muscle extending from the anterior edge of the paratergite of the third tergum to the membrane above the posterior lateral portion of the second sternum.
19. The tergal retractor of the third sternum (figures 3 and 4); a flat band extending from the posterior lateral region of the second tergum to the membrane before the anterior lateral corner of the third sternum.
20. The sternal retractor of the third tergum (figures 3 and 4); a cylindrical muscle extending from the posterior lateral region of the second sternum to the membrane before the paratergite of the third tergum. These re-

tractor muscles keep the four sclerotized plates of this region closely together, and fold the intervening membrane in an X-fold. When the female is gravid these muscles are stretched to an extreme degree, stretched so much that it is a wonder she can ever flatten her abdomen again, but she does.

21. The dilator of the second abdominal spiracle; similar in form and serially homologous to the dilator of the first abdominal spiracle.
22. The occlusor of the second abdominal spiracle; similar in form and serially homologous to the occlusor of the first abdominal spiracle.
23. The longitudinal retractor of the third abdominal sternum (figure 4); a broad, flat sheet extending from the anterior margin of the second sternum to the membrane before the anterior margin of the third sternum.
24. The protractor of the third abdominal sternum (figure 4); a wide, flat group of bundles extending from the posterior region of the second sternum to the membrane before the anterior margin of the third sternum.

The musculature of the third abdominal segment is typical for the pregenital segment of the Carolina mantis. In figure 5 are the muscles of the third segment of the male, which are similar to those of the female shown in figure 6.

25. The longitudinal retractor of the fourth tergum (figures 5 and 6); three groups of bundles acting as a single muscle, extending from the middle of the third tergum to the membrane before the fourth tergum.
26. The protractor of the fourth tergum (figures 5 and 6); a short, flat band extending from the posterior region of the third tergum to the membrane before the fourth tergum.
27. The oblique retractor of the fourth tergum (figures 5 and 6); a flat band extending from the posterior region of the third tergum to the membrane before the anterior lateral margin of the fourth tergum.
28. The anterior tergosternal muscle (figures 5 and 6); a cylindrical muscle extending from the midlateral region of the third tergum to the midlateral part of the third sternum.
29. The posterior tergosternal muscle (figures 5 and 6); a slender, cylindrical muscle extending from the posterior lateral region of the third tergum to the posterior lateral region of the third sternum.
30. The anterior lateral retractor of the third sternum (figures 5 and 6); a radiating group of bundles extending from the anterior lateral region of the third tergum to the membrane above the anterior lateral rim of the third sternum.
31. The posterior lateral retractor of the third sternum (figures 5 and 6); a short, flat band extending from the anterior border of the paratergite of the fourth tergum to the membrane above the posterior lateral edge of the third sternum.
32. The tergal retractor of the fourth sternum (figures 5 and 6); a slender muscle extending from the posterior lateral region of the third tergum to the membrane above the anterior lateral corner of the fourth sternum.
33. The sternal retractor of the fourth tergum (figures 5 and 6); a muscle extending from the posterior lateral region of the third sternum to the membrane before the paratergite of the fourth tergum.

34. The dilator of the third abdominal spiracle (figure 19); a slender, flat band extending from the paratergite to the dilator process of the lower portion of the anterior spiracular lip.
35. The occlusor of the third abdominal spiracle (figure 19); a stout little muscle extending from the occlusor process of the posterior spiracular lip to the dilator of the anterior lip.
36. The longitudinal retractor of the fourth sternum (figures 5 and 6); three flat bands acting as a single muscle, extending from the middle of the third sternum to the anterior border of the fourth sternum.
37. The protractor of the fourth sternum (figures 5 and 6); a band extending from the posterior region of the third sternum to the anterior border of the fourth sternum.

Since the musculatures of the fourth, fifth, and sixth segments of the female, and the fourth, fifth, sixth, and seventh of the male are identical there is no need for describing them in detail. A table of serial homology will suffice.

SEGMENTS.......	III	IV	V	VI	VII (Male)
Muscles.........	25	38	51	64	77
	26	39	52	65	78
	27	40	53	66	79
	28	41	54	67	81
	29	42	55	68	82
	30	43	56	69	83
	31	44	57	70	118
	32	45	58	71	119
	33	46	59	72	84
	34	47	60	73	120
	35	48	61	74	121
	36	49	62	75	85
	37	50	63	76	86

In the seventh, and eighth, the genital segments, the ninth, tenth, and eleventh, the postgenital segments of the female mantis are the following muscles:

77. The longitudinal retractors of the eighth tergum (figures 12 and 13); three flat bands functioning as a single muscle, extending from the middle of the seventh tergum to the membrane before the eighth tergum.
78. The median oblique retractor of the eighth tergum (figure 13); a flat, flaring muscle extending from the posterior median area of the seventh tergum to the membrane before the eighth tergum.
79. The intermediate oblique retractor of the eighth tergum (figures 12 and 13); two groups of bundles extending from the posterior lateral region of the seventh tergum to the anterior lateral margin of the eighth tergum.
80. The lateral oblique retractor of the eighth tergum (figures 12 and 13); a group of short bundles extending from the posterior lateral region of the seventh tergum to the anterior lateral margin of the paratergite of the eighth tergum.

81. The anterior tergosternal muscle of the seventh segment (figure 12); a cylindrical muscle extending from the posterior lateral region of the seventh tergum to the anterior lateral region of the seventh sternum.
82. The posterior tergosternal muscle of the seventh segment (figure 12); a slender muscle extending from the posterior lateral region of the seventh tergum to the anterior lateral region of the seventh sternum.
83. The anterior lateral retractor of the seventh sternum (figure 12); a flat band extending from the anterior lateral region of the seventh tergum to the membrane above the anterior lateral margin of the seventh sternum. This muscle also aids in the retraction of the seventh sternum.
84. The posterior lateral retractor of the seventh sternum (figure 13); a flat muscle extending from the upper anterior margin of the paratergite of the eighth tergum to the membrane above the posterior lateral margin of the seventh sternum.
85. The dilator of the seventh abdominal spiracle; similar in form and serially homologous to 34 of the third segment.
86. The occlusor of the seventh abdominal spiracle; similar in form and serially homologous to 35 of the third segment.
87. The lateral sternal retractor of the ovipositor base (figures 7, 11, 12); a stout muscle extending from the anterior lateral corner of the seventh sternum to the lower tip of the united paratergites of the eighth and ninth terga. In addition to the retraction of the ovipositor base this muscle serves to brace the tip of the paratergites against the more distal muscles of the ovipositor.
88. The paratergital levator of the seventh sternum (figure 11); a short, thick muscle extending from the tip of the paratergites of the eighth and ninth terga to the midlateral region of the seventh sternum.
89 The paratergital levator of the gonopod of the ninth segment (figures 7 and 11); a short, thick muscle extending from the tip of the paratergites of the eighth and ninth terga to the outer basal rim of the dorsal collinea. This muscle also extends the gonopod laterally.
90. The tergal levator of the gonopod of the ninth segment (figures 7 and 13); a short, flat muscle extending from anterior lateral region of the ninth tergum to the membrane near the outer basal rim of the dorsal collinea.
91. The paratergital abductor of the ventral collinea (figure 7); a wide, folded muscle extending from the intersegmental ridge of the united paratergites of the eighth and ninth terga to the lower outer portion of the basal rim of the ventral collinea.
92. The tergal abductor of the ventral collinea (figures 7, 12, 13); a two-piece muscle extending from the anterior lateral region of the eighth tergum to the lower outer portion of the basal rim of the ventral collinea.
93. The paratergital adductor of the ventral collinea (figure 7); a two-piece muscle extending from the intersegmental ridge between the paratergites of the eighth and ninth terga to the membrane near the upper inner portion of the ventral collinear base.
94. The sternal abductor of the dorsal collinea (figure 7); a short, thick muscle extending from the sternum and its apophysis of the ninth segment to the outer basal rim of the dorsal collinea.

95 The accessory sternal abductor of the dorsal collinea (figure 7); a short muscle extending from the ninth sternum to the lower portion of the dorsal collinear base.

96. The abductor of the median collinea (figures 7 and 9); a muscle extending from the lower outer portion of the basal rim of the dorsal collinea to the inner basal wall of the median collinea.

97. The lateral muscle of the dorsal collinea (figure 8); a wide, flat muscle extending from the lateral wall of the dorsal collinea to the membrane of its inner basal rim.

98. The collineafer muscle of the ventral collinea (figure 10); a short, thick muscle extending from the inner basal wall of the collineafer region to the outer basal wall of the ventral collinea.

99. The sternal retractor of the genital chamber (figure 7); a slender, flat band extending from the anterior border of the seventh sternum to the anterior edge of the genital chamber.

100. The sternal protractor of the genital chamber (figure 12); a flat, flaring muscle extending from the central part of the seventh sternum to the lower wall of the genital chamber. This part of the genital chamber is sclerotized and has been identified as the eighth sternum. It might be claimed that this protractor muscle is fundamentally a retractor on the eighth sternum, but it should be noted that the muscle apex is on the morphologically posterior border of the sclerotic plate.

101. The longitudinal protractor of the ninth tergum (figures 12 and 13); three flat bands functioning as a single muscle, extending from the anterior border of the eighth tergum to the anterior border of the ninth tergum.

102. The median oblique retractor of the ninth tergum (figure 13); a wide, flat band extending from the anterior median area of the eighth tergum to the anterior lateral margin of the ninth tergum.

103. The intermediate oblique retractor of the ninth tergum (figures 12 and 13); a flat muscle extending from the anterior lateral region of the eighth tergum to the anterior lateral margin of the ninth tergum.

104. The lateral oblique retractor of the ninth tergum (figures 12 and 13); a flat muscle extending from the midlateral region of the eighth tergum to the anterior lateral margin of the ninth tergum.

105. The dilator of the eighth abdominal spiracle; similar in form and serially homologous to 34 of the third segment.

106 The occlusor of the eighth abdominal spiracle; similar in form and serially homologous to 35 of the third segment.

107. The longitudinal protractor of the tenth tergum (figures 12 and 13); three flat bands functioning as a single muscle, extending from the anterior border of the ninth tergum to the anterior border of the tenth tergum.

108 The median oblique retractor of the tenth tergum (figures 13 and 15); a flat, flaring muscle extending from the anterior median border of the ninth tergum to the anterior lateral margin of the tenth tergum.

109. The lateral oblique retractor of the tenth tergum (figure 15); a twisted band extending from the anterior lateral border of the ninth tergum to the anterior lateral corner of the tenth tergum.

110. The lateral retractor of the paraproct (figures 12 and 13); a long, flat muscle extending from the anterior lateral border of the ninth tergum to the lower basal rim of the paraproct.
111. The longitudinal retractor of the eleventh tergum (figures 12, 13, 15); a slender band extending from the anterior median border of the tenth tergum to the anterior border of the eleventh tergum.
112. The median retractor of the paraproct (figures 13 and 15); a two-piece muscle extending from the anterior median region of the tenth tergum to the upper median border of the paraproct.
113. The dorsal flexor of the cercus (figure 15); a flat, flaring muscle extending from the anterior median area of the tenth tergum to the inner dorsal portion of the cercal base.
114. The ventral flexor of the cercus (figure 15); a flaring band extending from the anterior border of the tenth tergum to the inner ventral portion of the cercal base.
115. The dorsal extensor of the cercus (figure 15); a flaring band extending from the anterior lateral region of the tenth tergum to the outer dorsal portion of the cercal base.
116. The ventral extensor of the cercus (figure 15); a short muscle extending from the curled lateral portion of the tenth tergum to the outer ventral portion of the cercal base.
117. The median retractor of the paraproct (figures 12 and 13); a flat band extending from the lower base of the paraproct to the lower distal region of the paraproct.

The rectal dilator muscles are not included in this study because the specimens available were not fixed well enough for the dissection of such muscle bundles.

In the eighth, ninth, tenth, and eleventh segments of the male are some muscles which are obviously serially homologous to those in the posterior segments of the female, some which are probably strongly modified homologues, and others which are special male developments.

101. The longitudinal retractor of the ninth tergum (figure 18); three flat bands functioning as a single muscle extending from the anterior region of the eighth tergum to the membrane before the anterior border of the ninth tergum. Homologous to 101 of the female.
102. The oblique protractor of the ninth tergum (figure 18); a flat, flaring band extending from the posterior median region of the eighth tergum to the membrane before the anterior border of the ninth tergum. Homologous to 102 of the female.
103. The intermediate oblique retractor of the ninth tergum (figure 18); a flat band extending from the posterior lateral region of the eighth tergum to the anterior lateral margin of the ninth tergum. Homologous to 103 of the female.
104. The lateral oblique retractor of the ninth tergum (figure 18); a flat band extending from the posterior lateral region of the eighth tergum to the anterior lateral margin of the ninth tergum. Homologous to 104 of the female.

122. The anterior tergosternal muscle of the eighth segment (figure 18); a stout muscle extending from the midlateral region of the eighth tergum to the midlateral region of the eighth sternum. Probably homologous to 92 of the female.
123. The sternal retractor of the ninth tergum (figure 18); an oblique muscle extending from the posterior lateral region of the eighth sternum to the anterior lateral corner of the ninth tergum.
124. The longitudinal retractor of the ninth sternum (figure 18); a flat band extending from the anterior border of the eighth sternum to the anterior border of the ninth sternum.
125. The median protractor of the ninth sternum (figure 18); a flat band extending from the posterior median region of the eighth sternum to the anterior median border of the ninth sternum.
126. The lateral protractor of the ninth sternum (figure 18); a cylindrical muscle extending from the posterior median region of the eighth sternum to the anterior lateral corner of the ninth sternum. This muscle also twists the sternum.
107. The longitudinal retractor of the tenth tergum (figure 18); three bands functioning as a single muscle extending from the anterior border of the ninth tergum to the anterior border of the tenth tergum. Homologous to 107 of the female.
108. The oblique protractor of the tenth tergum (figure 18); a long, flat band extending from the posterior median region of the ninth tergum to the anterior lateral border of the tenth tergum. Homologous to 108 of the female.
109. The lateral oblique retractor of the tenth tergum (figure 18); a muscle extending from the posterior lateral region of the ninth tergum to the curled anterior lateral portion of the tenth tergum. Homologous to 109 of the female.
127. The tergal retractor of the ninth sternum (figure 18); a thick, flat band extending from the lateral region of the ninth tergum to the anterior lateral edge of the ninth sternum.
128. The sternal retractor of the intersternal membrane (figure 18); a wide, flat band extending from the anterior lateral edge of the ninth sternum to the intersternal membrane above the ninth sternum.
129. The left paraproctal muscle of the right lobe of the male genitalia (figure 23); a flat band extending from the lower border of the left paraproct to the median process of the right genital lobe.
130. The right paraproctal muscle of the right genital lobe (figure 23); a flat band extending from the lower border of the right paraproct to the median process of the right genital lobe.
131. The median retractor of the ventral membrane of the right genital lobe* (figure 23); a wide, flat band extending from the median process to the middle of the ventral membrane of the right genital lobe.
132. The distal flexor of the right genital lobe (figure 23); a cylindrical muscle extending from the middle of the lateral process of the right genital lobe to the upper surface of its distal cap.
133. The basal retractor of the right genital lobe (figure 23); a cylindrical

* The muscles of the genital lobes of the male are not paired muscles.

muscle extending from the middle of the lateral process of the right genital lobe to the anterior median border of the ninth sternum.

134. The retractor of the right genital lobe (figure 23); a cylindrical muscle extending from the base of the ventral sclerite of the median lobe to the basal lip of the lateral process of the right lobe.
135. The basal flexor of the right genital lobe (figures 23 and 24); a flat muscle extending from the inner surface of the lateral process of the right genital lobe to the midventral region of the lobe.
136. The dorsoventral muscle of the right genital lobe (figure 24); a small flaring muscle extending from the upper surface of the midlateral region of the lobe to the crescenteric sclerite in the midventral region of the lobe.
137. The interlobular muscle between the right and left genital lobes (figure 22); a flat, flaring band extending from the tip of the median process of the right lobe to the median apophysis of the left lobe.
138. The apophyseal tensor of the left genital lobe (figure 22); a wedge-shaped muscle extending from the median apophysis of the left lobe to the median portion of the lateral sclerite of the left lobe.
139. The flexor of the lateral sclerite of the left genital lobe (figures 21 and 22); a slender muscle extending from the median portion of the lateral sclerite to the ventral surface of the earlike lobe of the median genital lobe.
140. The flexor of the median apophysis of the left lobe (figure 21); a large muscle extending from the lateral basal region of the ventral sclerite of the left lobe to the base of its median apophysis.
141. The retractor of the ventral sclerite of the left lobe (figures 20 and 21); a stout muscle extending from the basal region of the ventral sclerite of the median lobe to the lower surface of the lateral basal region of the ventral sclerite of the left lobe.
142. The median depressor of the left lobe (figures 20 and 21); a curved, flat band extending from the midventral region of the ventral sclerite of the median genital lobe to the inner basal sclerite of the left lobe.
143. The retractor of the tip of the median genital lobe (figure 20); a large, stout muscle extending from the middle of the ventral sclerite of the median lobe to the membrane before the tip.
144. The protractor of the median genital lobe (figure 21); a large muscle extending from the anterior median region of the ninth sternum to the basal rim of the median lobe.

I shall not defend the names of these genital muscles very strongly, for it would take more observation of the movements of the genital lobes than I have made to interpret the functions of their muscles.

In the tenth segment of the male are the muscles of the eleventh tergum, the paraprocts, and the cerci, all similar to those of the female:

111. The longitudinal retractor of the eleventh tergum (figure 18); a slender, flat band extending from the anterior border of the tenth tergum to the anterior border of the eleventh. Homologous to 111 of the female.

112. The median retractor of the paraproct (figure 18); a single band extending from the anterior border of the tenth tergum to the upper median border of the paraproct. Homologous to 112 of the female.
113. The dorsal flexor of the cercus (figure 18); similar in form and homologous to 113 of the female.
114. The ventral flexor of the cercus (figure 18); similar in form and homologous to 114 of the female.
115. The dorsal extensor of the cercus; similar in form and homologous to 115 of the female.
116. The ventral extensor of the cercus; similar in form and homologous to 116 of the female.
110. The lateral retractor of the paraproct (figure 18); similar in form and homologous to 110 of the female.
117. The median retractor of the paraproct (figure 18); similar in form and homologous to 117 of the female.

REFERENCES

See Snodgrass, R. E., "The Abdominal Mechanisms of a Grasshopper," Smiths. Misc. Coll., vol. 94, No. 6, 1935.

PLATE LXXVI

FIG. 1. Ventral muscles of second abdominal sternum.
FIG. 2. Lateral view of muscles of first abdominal tergum.
FIG. 3. Dorsal and lateral muscles between second and third segments.
FIG. 4. Lateral view of muscles of first and second segments.
FIG. 5. Lateral view of musculature of male third segment.
FIG. 6. Lateral view of musculature of female third segment.

PLATE LXXVI

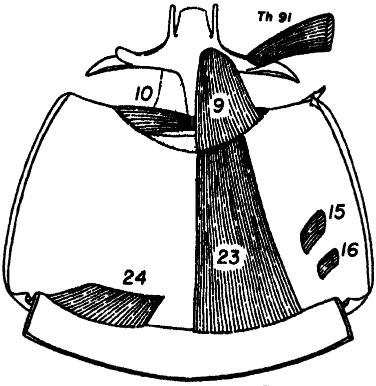

FIG. 1

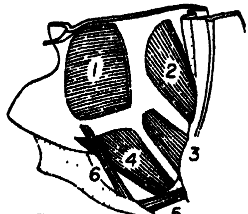

FIG. 2

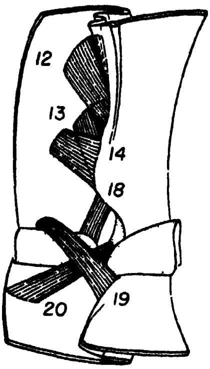

FIG. 3

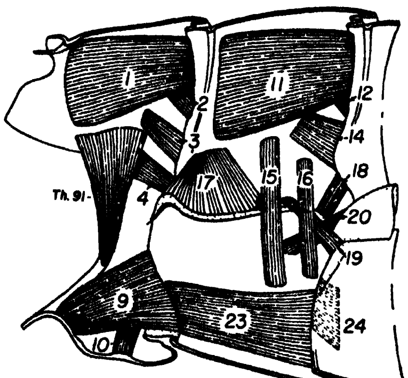

FIG. 4

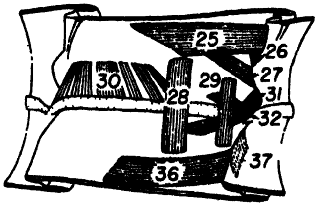

FIG. 5

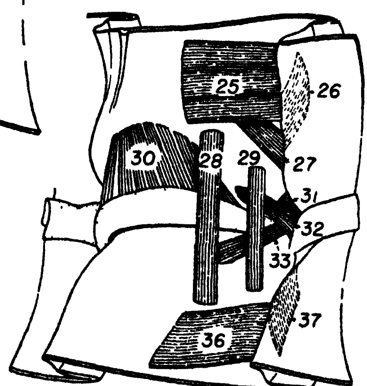

FIG 6

PLATE LXXVII

FIG. 7. Angular dorsal view of basal ovipositor muscles.
FIG. 8. Side view of basal muscles of right dorsal collinea.
FIG. 9. Side view of abductor of right median collinea.
FIG. 10. Side view of collineafer muscle of right ventral collinea.
FIG. 11. Angular dorsal view of ovipositor base with upper muscles removed.
FIG. 12. Lateral view of terminal segmental muscles of the female.

PLATE LXXVII

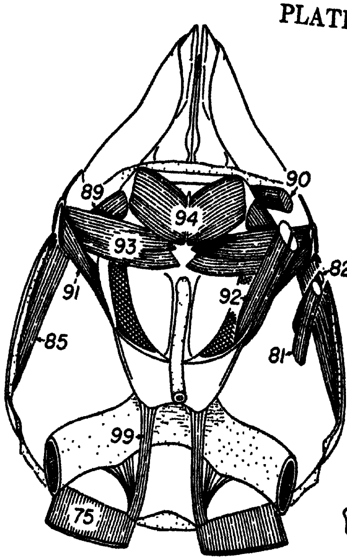

FIG. 7

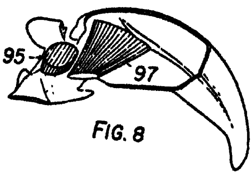

FIG. 8

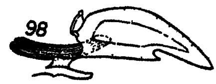

FIG. 9

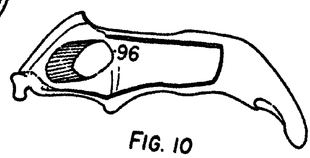

FIG. 10

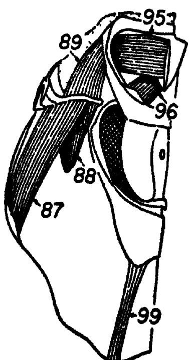

FIG. 11

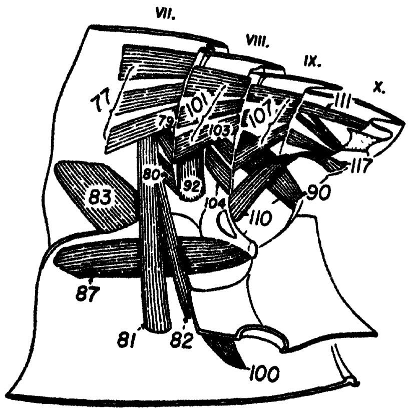

FIG. 12

PLATE LXXVIII

FIG. 13. Muscles of seventh, eighth, ninth, tenth, and eleventh terga of female.

FIG. 14. Muscles of first thoracic spiracle.

FIG. 15. Enlarged view of muscles of ninth, tenth, and eleventh terga of female.

FIG. 16. Muscles of second thoracic spiracle.

FIG. 17. Muscles of first abdominal spiracle.

FIG. 18. Lateral view of terminal segmental muscles of male.

FIG. 19. Muscles of third abdominal spiracle.

PLATE LXXVIII

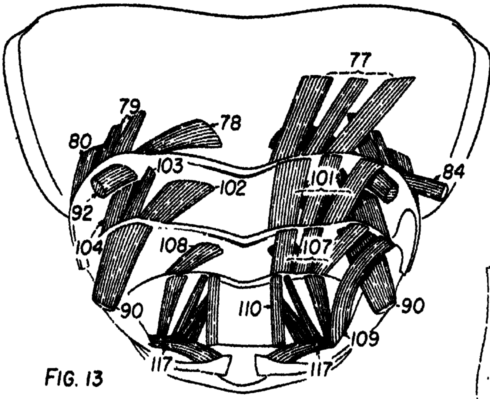

FIG. 13

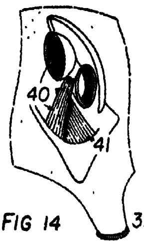

FIG 14

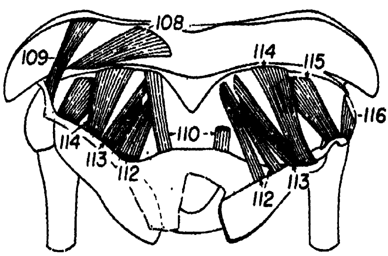

FIG. 15

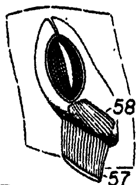

FIG. 16

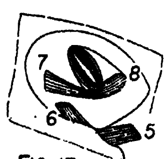

FIG. 17

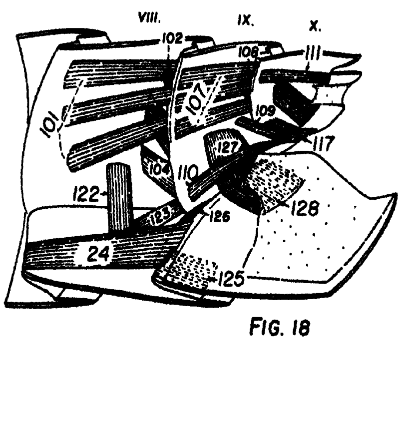

FIG. 18

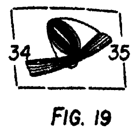

FIG. 19

PLATE LXXIX

FIG. 20. Muscles on median lobe of male genitalia.
FIG. 21. Muscles within left lobe of male genitalia.
FIG. 22. Muscles at base of left lobe of male genitalia.
FIG. 23. Muscles of right lobe of male genitalia.
FIG. 24. Lateral muscles in right lobe of male genitalia.

PLATE LXXIX

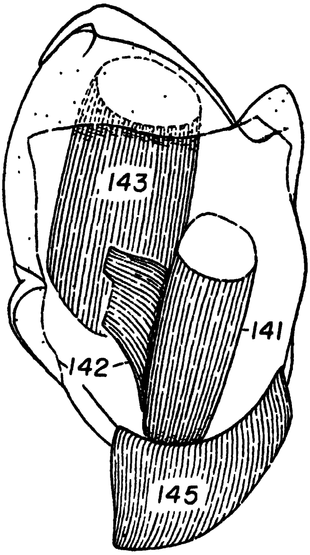

FIG. 20

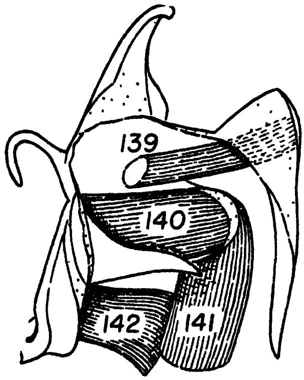

FIG 21

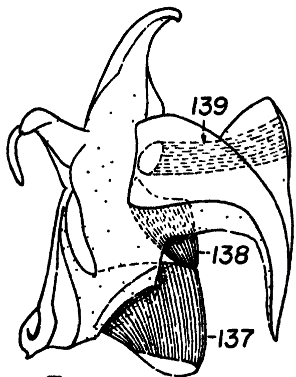

FIG. 22

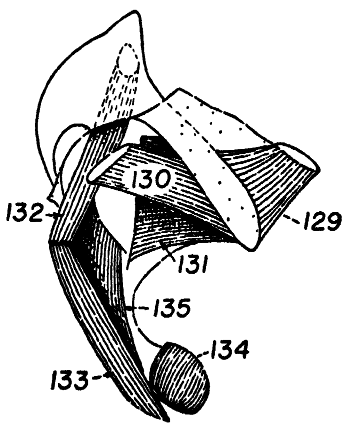

FIG. 23

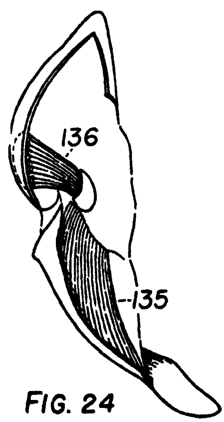

FIG. 24

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A Monographic Revision of the North American Species of Stenelmis (Dryopidae: Coleoptera)*

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ABSTRACT: This paper, according to its title, is a monographic revision of the North American species of Stenelmis. It contains virtually all that has been written on this genus of Dryopidae for the Western Hemisphere. This includes all that is known of the biology and morphology of the genus in addition to the taxonomy.

Approximately 600 species of Dryopidae have been described, of which sixty-eight belong to the genus Stenelmis. Fifteen species of this number have been described from North and South America, of which four species: *Stenelmis sulcata* Blatch. (*blatchleyi* Musgr.), *S. linearis* Zimm., *S. sordida* Mots., and *S. elongata* Mots. are reduced to synonymy in this paper. Eighteen species of Stenelmis are described here for the first time. They are: *Stenelmis sexlineata, S. exigua, S. beameri, S. lateralis, S. concinna, S. tarsalis, S knobeli, S. exilis, S. mera, S. douglasensis, S. grossa, S. parva, S. hungerfordi, S. mirabilis, S. antennalis, S. musgravei, S. decorata,* and *S. convexula.*

With the exception of *Stenelmis crenata* (Say), the types, cotypes, or paratypes have been examined for each of the American species. Since the type or types of *S. crenata* are lost, new types are designated.

The key to Stenelmis is based to some extent upon the color patterns of the elytra. Considerable use has, however, been made of the tarsal claws and segments, tubercles of the pronotum, apical abdominal emargination, granulation, the male genitalia, and a number of other characters not heretofore used. Males have been studied of all the species except two. With these exceptions, a figure of the genitalia is given for each species. This is the first time that a comparative study has been attempted of the male genitalia of Stenelmis. Technique is given for dissecting and mounting the genitalia.

A redescription or notes have been given for each of the American species.

A brief history of the classification of the entire family has been given from the time that the first Dryopid was described. The family was unknown to Linnaeus.

Although no fossil Stenelmis are known, a geological history of the family is given.

* Submitted to the Department of Entomology and the Faculty of the Graduate School of the University of Kansas in partial fulfillment of the requirements for the degree of doctor of philosophy.

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INTRODUCTION

SEVERAL years ago when I attempted to determine the material in the Dryopid genus Stenelmis in the Francis Huntington Snow collection at the University of Kansas, it became apparent that practically nothing could be done, with the present literature, toward the identification of our forms. Nearly all of the descriptions are brief, important structural characters were overlooked by early workers, and as a result the specimens of Stenelmis in most collections have been misidentified or set aside without names. Added to this difficulty, the specimens are usually clothed with an incrustation of dirt or other debris which has further rendered identification almost impossible. Thus, it became necessary to examine the types of our species in order to approach any accuracy of determination. With the exception of one, *Stenelmis crenata* (Say), the types have been studied.

No monographic studies have been attempted previously although LeConte (1852) and Horn (1870) brought our species together in synoptic arrangement. The purpose of this paper is to redescribe all known North American species of Stenelmis, to bring the scanty and scattered literature together, and to make known a number of new and interesting forms. Keys and illustrations are presented which, it is hoped, will aid in the identification of our species. For the sake of completeness, descriptions of *Stenelmis geayi* Grouv. and *Stenelmis nevermanni* Hntn., the only species known in the Western Hemisphere outside of the United States, are appended at the end of this paper.

ACKNOWLEDGMENTS

This opportunity is taken to express my deepest appreciation to Dr. H. B. Hungerford for the encouragement and support which have made the writing and publication of this paper possible. His readiness in aiding me to secure materials, to examine various types in the older collections, and to advise me on many problems under consideration, has been a constant stimulus. I am also greatly indebted to Dr. Paul N. Musgrave, Fairmont, W. Va., who submitted his large collection of Stenelmis for study, and kindly lent me much of the literature from his extensive library on Dryopoidea. His opinions on various questions relative to Dryopidae have been very valuable, and I take this opportunity to express my appreciation. To Dr. R. H. Beamer, of the University of Kansas, I owe my thanks for the large numbers of specimens of many interesting species which he has secured on his surveys over the United States.

Through the kindness of Dr. B. S. Cusin, of the Zoölogical Museum of Moscow, U. S. S. R., I have been permitted to examine the types of the species of Stenelmis described by Motschulsky (1859) from North America.*

To Mr. Guy Colas, of the National Museum at Paris, we are indebted for two specimens from the type series of *Stenelmis geayi* Grouv. And to Mr. Howard E. Hinton, of Berkeley, Cal., I am grateful for a paratype of *Stenelmis nevermanni* Hntn.

To the following I am indebted for the loan of material: University of Minnesota; Canadian National Museum; Warren Knaus, McPherson, Kan.; Kansas State College; C. A. Frost, Framingham, Mass.; O. L. Cartwright, Clemson College, S. C.; P. W. Fattig, Emory University, Ga.; Cornell University, Ithaca, N. Y.; Dr. H. H. Knight, Iowa State College.

I am grateful for the privilege of studying the collections of Prof. W. S. Blatchley, Indianapolis, Ind.; the collections of the Museum of Comparative Zoölogy, Harvard College; and the Horn collection at the Philadelphia Academy of Sciences.

To Mr. H. C. Fall, Tyngsboro, Mass.; Dr. Lyman S. Henderson, my fellow student; to Mr. C. W. Sabrosky, East Lansing, Mich.; and to all others who have aided in this project, I wish to give my sincere thanks.

The location of types is indicated after the description of each species.

HISTORICAL REVIEW OF STENELMIS IN NORTH AMERICA

The genus Stenelmis was first proposed by Leon Dufour in 1835 (Add. des Sci. Nat. Second Serie, tome III, p. 158) for the reception of *Elmis canaliculata* Gyll., a species described in 1808 from Europe. Later *Elmis crenata* Say, described in 1924 from Pennsylvania, was transferred to this genus. In 1852 LeConte named two more species in the United States, S. *sinuata*, and *S. bicarinata*. In 1859 Motschulsky described *S. humerosa*, *S. märkelii*, *S. sordida*, and *S. elongata*. In 1869 Zimmerman added *S. linearis* and *S. vittipennis*. *S. quadrimaculata* Horn was described in 1870, at which time its author indicated the possible synonymy of *S. linearis* Zimm. with *S. humerosa* Mots. in the following statement: "This may be the species described by Motschulsky under the name of *humerosa*, and, if so, the latter should have priority. The descriptions of this and others are so vague as to leave considerable doubt of their

* *Stenelmis sordida, S. elongata, S. märkelii,* and *S. humerosa.*

identity." This conclusion, while correct, had not been verified until the present paper. In 1901 *S. nubifera* Fall was described and recorded as the first species of the genus from the Pacific coast. In 1910 Blatchley described *S. sulcata,* and in 1925, *S. fuscata.* In 1933 Musgrave discovered that the name *sulcata* had been used by Grouvelle (Not. Leyd. Mus. XIV, 1892, p. 188) for a species from Sumatra, and proposed the name *blatchleyi* for this species.

HISTORY OF CLASSIFICATION OF FAMILY

The following account is intended to give a brief history of the important changes in the family since the first species was described. Most of the information, until 1852, was taken from Mulsant and Rey (Hist. nat. col. Fr. 1872), and Zaitzev's account of the Dryopidae (Coleopterorum Catalogue, Vol. 14). The family was unknown to Linnaeus.

1785. Geoffroy (Foure. Ent. Paris, I, p. 20) was the first to describe a species of Dryopidae, *Dermestes auriculatus,* which he placed with the Dermestids.

1787. Fabricius (Mantissa Insectorum) described a species which he called *Elater dermestoides.*

1791. Olivier (Encycl. mèthod. VI, p. 298) proposed the generic name of Dryops for the species which Geoffroy had placed with the Dermestidae.

1792. Fabricius (Ent. Syst. I, p. 245) removed the species which he had described as an Elaterid and made it type of the genus Parnus. At the same time he described *Parnus prolifericornis.*

1793. Panzer (Fn. Germ. 7, p. 4) described a species which he called *Dytiscus volckmari.*

1798. Latreille (Bull. Soc. Philom. I-II) described the genus Elmis.

1802. Marsham (Entom. Brit. I, p. 192) placed the same insect in the genus Chrysomela.

1804. deBrives (Hist. Nat. IX, p. 227) associated Elmis and Dryops with the Byrrhidae, and also placed the Heteroceridae with the same family. Altogether they formed the group Ripicoles. He stated that Dryops and Gyrinids made up the family Otiophores.

1806. Müller (Illig. Mag. V, p. 184) adopted the name Limnius.

1807. deBrives (Gen. Crust. II, p. 48) preserved the family Otiophores.

1811. Germar (N. Schriften Nat. Ges. Halle 1, VI, p. 41) established the genus Potamophilus for *Parnus acuminatus* Fab.

1817. Leach (Cuv. Règne Anim. III, p. 268) changed the name Potamophilus to Hydera. This genus, Dryops, and Heterocerus form the second section of the family of Clavicornes.

1817. Leach (Zoöl. Misc. III, p. 88) placed Dryops with the Parnidea, and in addition Parnus and Potamophilus are placed in the same group.

1825. MacLeay (Annul. Javan. ed. I, p. 34) recognized the family Parnidae.

1828. Stephens (Ill. Brit. Ent. II, p. 102) divided the second section of the Clavicornes of Latreille into three families: Heteroceridae, Parnidae and Limnidae.

1839. Westwood (Intro. to the Modern Classification of Insects, Vols. I and II) adopted the divisions of Macleay. He called the Limnidae of Stephens a subfamily of Parnidae, but preferred the subfamily name of Elmidae.

1845. Redtenbacher (Die Gattungen der deutschen Käferf., Wien.) placed the Parnidae, Elmidae, and Heteroceridae after the Hydrophilidae. He placed the Georyssidae between the Dermestids and Byrrhids.

1847. Erichson (Naturg. Ins. Deutschl. III, p. 509) reunited all described Dryopids into a single family, the Parnidae. This was divided into two tribes, Unciferes and Diversicornes.

1852. LeConte divided the United States representatives of the family into three groups: Eurypalpini, which included the genus Eurypalpus (Psephenus); Dryopini, which included Iara, Lutrochus, Pelonomus, and Helichus; and the Elmini, which included Limnius, Elmis, Stenelmis, Macronychus and Ancyronyx.

1861. LeConte, in his Classification of the Coleoptera of North America (Smith. Miscell. Coll. 1861), considered the family Parnidae as containing three distinct subfamilies: Psephenidae, Parnidae (genuini) which contained the tribes Larini and Parnini, and the Elmidae.

1872. Mulsant and Rey (Hist. nat. col. Fr. XXII) retained the tribes Unciferes and Diversicornes of Erichson.

1870. Horn (Trans. Amer. Ent. Soc. III) recognized the three subfamilies of LeConte.

1883. LeConte and Horn (Smith. Miscell. Coll. 507), in their Classification of Coleoptera, recognized the subfamilies Psepheninae, Parninae, and Elminae.

1900. Lameere (Ann. Soc. Ent. Belg. XLIV, 363) proposed to unite Psephenus and also the Heteroceridae and Georyssidae with the Dryopidae. The family then was divided into the following subfamilies: Psepheninae, Parninae (including Heteroceridae), and Elmidinae (including Georyssidae).

1904. Ganglbauer (Die Käfer von Mitteleuropa) has used the subfamilies Dryopinae and Helminthinae.

1908. Zaitzev recognized the subfamilies Psephenini, Dryopini, and Helminthini.

1910. Zaitzev places the species in the Psepheninae, Dryopinae, and Helminae.

1910. Blatchley (Coleoptera of Indiana, p. 677) follows LeConte and Horn, recognizing the subfamilies Psepheninae, Parninae, and Elminae of the family Parnidae.

1920. Leng (Catalogue of Coleoptera) considered that Psephenus should constitute the family Psephenidae. The subfamily Parninae, or Parnidae of some authors, is raised to the family rank of Dryopidae, and the Elminae is raised to family rank, but is designated Helmidae.

1926. Forbes (Jr. N. Y. Ent. Soc. XXXIV, pp. 107-108) on a basis of wing folding patterns of Coleoptera recognizes the superfamily Dryopoidea

as constituting the Ptilodactylidae, Dryopidae (with Psephenus and Elmis), Chelonariidae, Heteroceridae, Byrrhidae (except Nosodendron) and the Mycetophagidae.

1927. Barthe (Miscellanea Entomologica, XXX, p. 4) follows Ganglbauer in the naming of subfamilies.

1927. West (Ann. Ent. Soc. Amer., XXII, p. 691), although acknowledging the usage of Psephenidae, Dryopidae, and Elmidae by Leng, preserves Psepheninae, Dryopinae, and Elminae as subfamilies of Dryopidae. His assumptions were based upon a study of the larvae.

1929. Carter and Zeck (Australian Zoölogist, VI, p. 51), in their Monograph of Australian Dryopidae, recognize the Psepheninae, Dryopinae, and Helminae.

1929. Böving (Bull. Brook. Ent. Soc., 24, p. 55) studied the larva of Lara and as a result concluded that it should constitute a separate family from the Dryopidae. This he named the Larridae. The genus Eubrianax, formerly included in the Dascyllidae, is placed with the Psephenidae. Other families, in addition to the Dryopidae, were Chelonariidae, Ptilodactylidae, and Psephenidae.

1930. Böving and Craighead (Entomologica Americana, XI, pp. 1-351) gave us our more recent general classification of the larvae of Coleoptera. Based upon a study of larval characters they recognized the series Dryopoidea under which were included the following families: Ptilodactylidae, Eurypogonidae, Psephenidae, Chelonariidae and Dryopidae. In this proposed classification the Heteroceridae is removed to the series Dascilloidea. The genus Eurypogon is removed from the Ptilodactylidae and given the rank of family. The Psephenidae is divided into the Psepheninae and the Eubrianacinae, the latter formerly having been included in the Dascyllidae. The Dryopidae included the subfamilies Larinae, Pelonominae (containing Pelonomus, Helichus and Psephenoides), and Helminae (containing Dryops, Helmis, Limnius, Ancyronyx, etc.). The Ptilodactylidae, Eurypogonidae, and Chelonariidae were formerly included in the Dascilloidea.

1930. Blackwelder (Pan. Pac. Ent., VI) also favors the placing of Eubrianax with the Psephenidae.

1930. Bradley (Manual of the Genera of Beetles of America North of Mexico) included the Psephenidae, Laridae, Dryopidae, Georyssidae, Chelonariidae, and Ptilodactylidae in the superfamily Dryopoidea. He mentioned that the family name Laridae is preoccupied by the family of sea gulls, though based on a differently spelled generic name.

1935. Hinton (Stylops, Vol. 4, p. 173) recognizes three subfamilies, Larinae, Dryopinae, and Elminae. He also considers the Psephenidae as a separate family.

1936. Darlington (Psyche, XLIII, pp. 65-83), in a paper on West Indian Dryopidae, recognized the subfamilies Psepheninae, Dryopinae, and Helminae.

1936. Hinton (Annals and Magazine of Natural History, Ser. 10, Vol. XVIII, p. 89) considers the same subfamilies as in his paper of 1935.

The generic names Elmis and Helmis have been used interchangeably since Helmis first was designated. Bedel (Ann. Soc. Ent. Fr., V, 1878, p. LXXV) added the "h" to Elmis, claiming that Latreille, being French, did not use the aspirate. Since the original transliteration was Elmis, there is no reason why the name Helmis should be used.

Musgrave (Proc. Ent. Soc. Wash., 37, 1935, pp. 137-138), in a discussion of Helichus, gives a brief review of the usage of Parnus and Dryops, and indicates why the name Parnus never should have been used. According to this author, "Helichus being very close to Dryops Olivier (Parnus Fabricius) was confused with the latter genus for more than a hundred years; and Erichson in his key to the Dryopini, which accompanied his original description, made the mistake of separating the two genera on approximate or distant hind coxae. . . . This error was noted by Sharp (Biol. Centr. Amer. I, Pt. 2, 1882, p. 120), who placed species in the genus Dryops Leach, making Helichus a synonym. Much of the confusion was caused by the fact that both Olivier (Encycl. method. VI, 1791, p. 297) and Leach (Zoöl. Misc. III, 1817, p. 88) described genera, applying the name Dryops. Dryops Oliv. (Parnus Fab.) is the correct name and is the true Dryops. The Dryops of Leach is the Helichus of Erichson and cannot be used because the name was previously used by Olivier. This fact validates Helichus Erichson, although the name did not appear until 1847. Parnus Fabricius (Ent. syst. I, 1, 1792, p. 245) is a synonym of Dryops Oliv.; and, therefore, species placed in Parnus belong to Dryops Oliv."

FAMILY CHARACTERISTICS

Dryopidae are usually characterized by being small, aquatic or subaquatic beetles, rarely over eight to ten millimeters in length, and having the following characters: head usually in part retractile and nearly always protected beneath by the prosternal lobe. In most species this lobe, while the head is in repose, meets the labrum and completely conceals the mouthparts. Antennae 7-11 segmented, the great majority of the species having the latter number. Prosternum generally with a posterior median process which fits into or against a groove on the mesosternum. Coxae usually widely separated, the anterior ones widely open behind. Hind coxae transverse and usually partly protecting the hind femora. Abdomen distinctly 5-segmented, the first few segments firmly united. Legs usually long and slender; tarsi 5-segmented and with the last segment often as long as the four preceding combined. Claws very long and generally robust.

BIOLOGY AND MORPHOLOGY

NEED FOR RESEARCH

An examination of the literature on the biology and morphology of Dryopidae indicates that much remains to be discovered. To my knowledge the complete life cycle of none of the species has been worked out, although we have considerable information on the development of the closely related family, Psephenidae. The larvae of but few of our species are known, the pupae of but two or three, and the eggs of one or two. Nothing has been done on the embryology. Only recently has anything been discovered regarding the tracheation of the larva, and information on the digestive and other systems is almost entirely lacking.

In 1835, at the time the genus Stenelmis was described, some information was given on the morphology of the adult, but nothing was known of the biology. Brocher (1912) has added some data on adult respiration, and suggests that this subject needs to be more fully developed.

The larvae and adults can be found in abundance in their natural habitat, so quantities of material may be had for study. The eggs of Stenelmis have been seen in the field once or twice, but I have obtained them only by the dissection of adult females.

LIFE HISTORY

Matheson (1914) was the first to record data on the immature stages of any of our species of Stenelmis. He found the full-grown larvae and pupae of *Stenelmis bicarinata* Lec. (latitude of Truro, Nova Scotia) under stones along the banks of the Salmon river. The larvae left the water about the last of July or the first of August. They constructed their pupal chambers in damp places under stones. Matheson found many pupae and larvae in such situations about August 7, and succeeded in rearing one adult from these pupae. It emerged on August 10. From this information it seeems probable that the pupal state may last two weeks or less. In July and August I have found adults and larvae of all stages in lakes and streams. Larvae kept under laboratory conditions for a period of four to six weeks have not been seen to moult. The data are insufficient to warrant a guess as to the probable length of the life cycle, but they suggest that the complete development may occupy a period of more than one year.

Recently Hinton (1936) has made some observations on the biology of *Dryops luridus* Er., a European species. Eggs were deposited from May to July. Some of the eggs were found inserted in

fresh and partly decayed stems and leaves of the water mint, Mentha, and still others were found at the bottom of the rearing jar. Hinton considered that oviposition normally occurs in plant tissue, but that the overcrowded conditions forced some females to lay their eggs free in the water. The eggs required about fifteen days to hatch. Rupturing of the chorion took place by body movements. According to Hinton (p. 72), "Two or more days before eclosion the larva may be seen frequently to shift to a slight extent its position inside the egg. It often actively moves its legs and mouth parts. No special apparatus exists for breaking the chorion, as has been observed for other beetles, such as Dytiscus. Probably no fluid is secreted, for if the egg be marked it is found to break open at places where the head of the larva has not been. On emerging, the larva usually begins to tunnel in the partly decayed stem or leaf in which the egg was laid. The larvae, both in nature and in captivity, seem to prefer partly decayed plant tissue. The duration of the life cycle and the number of instars has not been determined, nor have I been able to obtain pupae. I believe a complete life cycle probably requires two years. West (1929, p. 18) points out that in all probability the life cycle of *Psephenus lecontei* Lec. requires two years in northern latitudes."

In a related species (*Dryops auriculatus* Geoffr.), Brocher (1913, p. 227) has noticed the females depositing their eggs in damp places out of the water, though this may not be the usual habitat for the species.

RESPIRATION AND HABITS OF THE LARVA

The larvae of the various species of Stenelmis which I have examined are entirely aquatic and breathe by means of caudal filaments. The respiratory organ consists of three tufts of filaments which, in later instars, arises from a common stalk and which may be protruded from the caudal opening of the abdomen. The most important contribution to this subject is by Susskind (1936). This author treated the morphology and function of the respiratory system of several instars of *Stenelmis quadrimaculata* Horn. (*Stenelmis sulcata* Blatch.) She observed that the larvae expand and contract the filaments rhythmically when they are subjected to abnormal conditions such as rapid increase in temperature of water, exposure to light, high carbon dioxide tension, or low oxygen tension. The rhythm of expansion might be slow or rapid, depending upon the various conditions to which the larvae were subjected. The larvae often gathered themselves in a mass and remained quiet in this position for long periods. At such times the filaments usually

were retracted, and she suggested that under these circumstances respiration might go on without their use.

Adaptation of the larva to gradually changed conditions is generally effected without unusual disturbance to itself. If, however, the larva is suddenly subjected to warm water, the body is rapidly contorted in much the same manner as a mosquito larva.

The paper by Miss Susskind presented the various methods by which the tracheae of the larvae were prepared and studied. Furthermore, she has traced the various branches to the different parts of the body. The average number of filaments given for the middle tuft of caudal filaments is 55, and for the lateral tufts, 35. Two tracheoles, twisted about each other, are in each of the filaments. According to this author the spiracles do not appear until the last larval instar. There are ten pairs, two in the thorax and eight in the abdomen. The position of the spiracles is ventrolateral with one pair each in the mesothorax and metathorax, and one pair in each of the first eight abdominal segments. The aperture of the spiracle is described as being closed by two lightly sclerotized membranes which meet in a straight line parallel to the long axis of the body. The internal edges of the membranes are fused. She thought that the membranes prevent the entrance of water into the tubes and probably act as diffusion membranes.

By way of summarizing her paper, Miss Susskind has given the following tabular arrangement:

1. Both larvae and adults of *Stenelmis sulcatus* (*quadrimaculata* Horn) occur in marl concretions and are permanently submerged, never coming to the surface for air.

2. The larval tracheal system has fewer branches in the first instar than in all older larvae.

3. In the first larval instar neither spiracles nor spiracular tracheae are present.

4. The intermediate instar studied has spiracular tracheae, which are about half developed.

5. Last instar larvae have completely devolped spiracular tracheae and ten pairs of spiracles. The spiracular apertures are permanently closed by weakly chitinized membranes.

6. Larvae of all instars possess three tufts of caudal filaments at the posterior end of the main tracheal trunks. These tufts are protrusible through the tip of the last abdominal segment.

7. Intermediate and last instar larvae possess a caudal chamber associated with the caudal filaments.

8. The tracheal system of all larval instars is a closed one.

Hinton (1936) has figured a ventral view of the tracheal system of the larva of *Dryops luridus* Er. which, however, belongs to a

different subfamily from Stenelmis. This constitutes practically all that is known regarding respiration and respiratory systems of the larvae of this family.

I have observed in the field and laboratory the larvae of *Stenelmis quadrimaculata* Horn in marl concretions. They occur in immense numbers in Black Lake (Cheboygan county, Michigan), where they may be taken from their burrows in the concretions. Sometimes at the ends of these burrows a mass of larvae, often of various stages, is found. The larvae of the stream-dwelling species of Stenelmis crawl about beneath stones, in sand and in debris lodged in the stream. Hinton (1936) records the larvae of *Dryops luridus* Er. as having been taken, on one occasion, from damp places some distance from water. He suggested that since the larvae were in their last instar, the entire life cycle might take place out of water. I have collected larvae from running waters of all types, and also from the waters of lakes. Hinton's records are, therefore, interesting, and unusual if we consider the preferences of the great bulk of our Dryopidae.

RESPIRATION AND HABITS OF THE ADULT

Texts and other papers which discuss the respiration of aquatic insects rarely mention that it is unnecessary for adult Dryopids to come to the surface of the water to breathe. Except for the genus Haemonia (Chrysomelidae), other Coleoptera, although they may descend beneath the surface of the water to deposit their eggs (ex. Psephenidae), or may use this medium as a natural habitat (ex. Dytiscidae), are not known to remain there for indefinite periods without returning to the surface for air.

The body of a submerged dryopid is surrounded by a film of air which is held to it by the hydrofuge hairs. This silvery region is termed the "plastron" by Brocher, Muttkowski and others. This arrangement is not alone responsible for the insect's ability to remain under water indefinitely, for other aquatic Coleoptera have similar air-carrying capacities, yet they can remain under water only temporarily.

The researches of Brocher (1912) have contributed much regarding the respiration of adult Dryopidae. I shall make no attempt to cover his extensive paper on this subject, but hope to present some of his interesting experiments and conclusions, especially regarding *Stenelmis canaliculata* (Gyll.).

Brocher, at first, studied certain European species, including the

above Stenelmis, under laboratory conditions. The jars in which they were placed contained sand, stones with calcareous incrustations, and some aquatic plants such as Hypnum. They were kept in a cool, well-lighted place, but out of the direct rays of the sun. Under these conditions, the plants liberated a great deal of oxygen, the water temperature did not rise, and there was an abundance of food. The beetles behaved as they did in their natural habitat and remained in perfect health. Some of the adults were placed in a small jar, the mouth of the jar was closed with muslin and submerged in a larger jar of water. They remained thus for 140 days, when the experiment was interrupted, at which time they were still in perfect health. During this time the adults were not always observed with a bubble of air at the tip of the body, nor were the beetles found floating inactive at the surface of the water. When the conditions of existence became unfavorable, such as too few plants in the jar, or too feeble illumination, the beetles were disturbed. Some moved about with a bubble at the tip of the abdomen; they were often seen rising to the surface, supported here by the bubble. If the bubble burst, the insect immediately fell to the bottom of the aquarium. Brocher concluded, after this observation, that the beetle did not come to the surface for air. He mentions that these insects are the first to die when the water of the aquarium is insufficiently aerated.

Proof that Dryopidae obtain some of the oxygen necessary for respiration from plants presented itself to Brocher on two occasions. Adults were observed, upon encountering a bubble of air adhering to the plant, "to eat with frenzy at this spot." The silvery region of the head absorbed some of the oxygen, gradually relaying it to other parts of the body. He did not observe air in the mouth of Stenelmis, which led him to suppose that the absorption of oxygen must have taken place in other regions of the body.

He further observed that the Dryopidae were able, while feeding on plants, to gather quantities of oxygen which oozed out of the tissues. The oxygen, apparently, was absorbed by the silvery surface of the body. The fact was mentioned that it was important to the insect not to take up too large a quantity of gas at one time since the specific weight of its body would be lowered. In this event the beetle might float to the surface of the water once it lost its hold upon a support.

After having studied the habits of healthy Dryopids, Brocher thought it worth while to study certain beetles in which the functions

of respiration had been disturbed. One experiment was to force the beetles to stay in a poor oxygen medium, such as boiled water, or in water charged with carbonic acid. When the bubble of air appeared at the end of the body, it was removed. In addition, the silvery region of the body was mechanically removed or the end of an elytron was cut off. When they were transferred back to the proper conditions of the aquarium, the insects appeared to be more active than those that were kept in the normal state.

It was found that when the hairs which support the silvery region of the prosternum, mesosternum, and metasternum were completely removed by scraping with the point of a needle, the beetle died within one or two days. When only the silvery region of the prosternum was destroyed, the beetle was able to survive for a longer time and apparently in good condition. The facts, according to Brocher, appear to demonstrate that the silvery regions fulfill an important physiological function which can only be respiratory.

The respiratory system is described by Brocher as being composed of the silvery hydrofuge surface, the dorsal space under the elytra, and the tracheal system. In Stenelmis the silvery region was described as occupying the dorsal surface of the head and prothorax and all of the ventral face of the body, including the femora. I have also observed this region covering the tibiae. When these surfaces were examined under the microscope, many granules were found, each provided with a long hair. Brocher regarded these granules as organs destined to capture the minute bubbles of gas which by chance come into contact with the silvery regions. The bubbles came to rest collectively on the granules and little by little were absorbed.

Brocher described nine pairs of spiracles in the adult. The first pair was situated in the membrane between the prothorax and the mesothorax. These were termed the "mesothoracic spiracles." The "metathoracic spiracles" were situated in the lateral membrane of the metathorax opposite the coxal cavity. They are much less prominent than the mesothoracic ones. Raising of the elytra and wings revealed seven pairs on the dorsal face of the abdomen.

The hydrofuge hairs are continuous, from the ventral surface of the abdomen, along the groove under the edge of the elytra, and to the spiracles. By this route the oxygen may pass directly to the spiracles where it can be used for respiration or to the subelytral space for storage. It is thought that the oxygen which comes to the silvery regions of the prothorax, by way of the mouthparts, arrives

at the mesothoracic spiracles which may act as inspiring spiracles. Frequently, however, they may serve for expiration, for bubbles have been observed to issue from them. The metathoracic spiracles have a direct relationship with the hydrofuge regions or the ventral surface of the body, as has been pointed out for the abdominal ones.

Frequently Brocher noticed that when a Dryopid was placed on its back and further disturbed by teasing, a bubble of air appeared on each side of the posterior coxae. He was led to believe, from this observation, that expiration also took place in the abdominal spiracles. By pressing lightly on the abdomen, I have noticed that a bubble of air appeared at the tip of the body. Another specimen, when turned on its back, released two bubbles of air from the region of the left hind coxa, and another from the left middle one.

I have observed the adults of *Stenelmis quadrimaculata* Horn feeding upon algae in marl incrustations. Specimens taken from a stream and brought into the laboratory with dead leaves were found to "graze" over both surfaces. They were, apparently, feeding upon an algaelike growth. When no leaves or stones containing their food were placed with them, they proceeded to feed upon the debris on one another.

The tarsi of the adult Stenelmis are terminated by two long claws which enable them to cling to stones in the swiftest of streams. They seldom come to the surface during the day, but at night the winged species often leave the stream, pond, lake, or other natural habitat and take wing. They have been taken at lights by hundreds in various localities. Frequently several species may be observed in these flights. This indicates a positive phototropism, though during the day they generally prefer the dark recesses of their habitat. In at least one instance, however, I have found adults of a Dryopid, *Heterlimnius corpulentus* (Lec.), during a bright day, resting on stones jutting out of a stream.

DESCRIPTION OF THE LARVA

Matheson (1914) briefly characterized the larva of *Stenelmis bicarinata* Lec. The full-grown larva is described as having the head and terminal segment of the abdomen nearly black. The antennae are briefly described and measurements are given for each segment. Following Matheson, we have the next important contribution, on larvae of Dryopids, by West (1929). This author discusses eight types of larvae and, in addition, the larva of *Psephenus herricki* (DeKay) (Psephenidae). His description of an unidentified Stenelmis follows:

"Larva elongate, of the form of an attenuated hemicylinder, *i. e.*, with ventral surface nearly flat, but with dorsum arched, so as to appear in cross section semicircular. Median dorsal line but faintly indicated; not elevated into a carina of any sort. Prothorax one and one-half times the length of the succeeding segment. Seen in dorsal view, margins of all body segments except the last appear bisymmetrically rounded, the margin of the prothorax alone being very slightly sinuate. Posterior abdominal segment subconical; the dorsal sclerite rather abruptly narrowed posteriorly and terminating in two sharp points. Ventral sclerite occupying posterior half of segment, ot the form of a quadrangle with an equilateral triangle attached posteriorly; with two elongate, slender appendages, bearing numerous spines, and recurved at the tips. Entire dorsal surface of the larva, except the head, covered with a close sprinkling of fine tubercles, each of which tends to give rise to a minute, backward directed spine. These tubercles tend to be replaced by spines on posterior segments. Those spines along the posterior margin of each segment are more stout and elongate, forming a ciliate border to the segment. Larva slightly broadest in the region of the first two or three abdominal segments; diminishing slightly in size both anteriorly and posteriorly from this point.

"Head large, exserted, rather conspicuous, being nearly three fourths as broad as prothorax; with conspicuous Y-shaped epicranial suture visible dorsally. Antennae short, composed of three segments; the first rather deeply inserted and but slightly longer than broad, the second much more slender, fully twice the length of the first and, seen laterally, more expanded at distal end than at the base; the third duplicate, being composed of two small, transparent articles arranged side by side, the one gradually tapering, the other more robust and of the same diameter throughout. No terminal spine has been demonstrated on either of these articles. Ocelli situated behind the antennae, each group composed of apparently five units. Labrum simple, with lateral margins evenly rounded; slightly emarginate anteriorly. Anterior and lateral margins, as well as entire upper surface, beset with rather stout spines. Mandibles subtriangular, distinctly tridentate, and bearing a large "taste-brush" (prostheca) on the inner surface at about one third the distance from base to tip. Outer surface bearing at least two branching spines. Maxillae small, with four-segmented palpi. Stipes, near base of palpus, bearing at least one stout branching spine. Small area on distal portion of last palpal segment provided with papillae, evidently tactile in function. Lacinia lying close upon galea and of the usual form, *i. e.*, resembling a truncate sleeve, or cylinder, open along the exposed surface and adorned distally with a variable number of stout spines. Galea without characteristic form, bearing distally several stout curving spines. Labium membranous, nearly twice as long as broad, and bearing three-segmented palpi, of which the third segment is much the smallest and bears distally a small sensory area, where are located usually four tactile papillae. Outside of, and opposite to first palpal segment may be found, on each side, a short, studded spine. Mentum rather clearly bounded by a suture at the base of the palpi. Distal portion of labium evenly convex and adorned with a great number of fine, tactile hairs.

"Legs composed of the usual parts and adorned with a rather scanty covering of spines. Coxae somewhat excavated anteriorly, and thus adapted for

reception of femora. Distal portion of excavation cushionlike in appearance, with a mass of small, closely ranged tubercles. Claw bearing on its inner surface a slender and sometimes curving spine. Gills caudal, arranged in three principal tufts and capable of extrusion between the sclerites of the posterior abdominal segments. Spiracles situated laterally, one pair on the mesothorax and one pair on each of the first eight abdominal segments. Length of mature larva, 6.5 mm. Greatest width (at first abdominal segment), .91 mm.

"Description drawn from several specimens taken at Walnut Creek, Michigan, and assigned to Stenelmis since several adults of that genus were associated with them. Also the larva of *Stenelmis bicarinatus* Lec., as figured by Matheson ('14), comes closer to this type than to any other studied so far."

Plate I, figures 8 and 9, and Plate IV in West's paper illustrate larvae and certain morphological characters. In West's discussion of the larvae, a comparison is made of the larval types and he attempts to correlate structures of the larvae with their habitats. Comparisons are made chiefly with Psephenus, Helichus, Elmis (European) and Stenelmis.

The lateral lobes of the body segments of Psephenus are developed to a high degree, but, when one proceeds through the series to Stenelmis, the lobes are found here to be entirely lacking. Comparison of the respiratory apparatus, especially position, is of some significance in the series. In Psephenus the respiratory gills are ventral; in all others they are caudal. The structure of the caudal abdominal segment is described by West as being strikingly similar in most of the larvae having caudal gills. Position of the head in Psephenus and Helichus is beneath the expansion of the prothorax, but in others the head is visible from the dorsum.

Following this discussion West attempts to show natural groupings within the family on the basis of larval characters. An interpretation is given from an evolutionary point of view. A key, including several European forms, is presented for the few larval types.

Böving and Craighead (1930), in their extensive paper on the principal larval forms of Coleoptera, figure a mandible, head and antenna, maxilla, and a lateral view of the ninth tergite and tenth sternite of *Stenelmis crenata* (Say). Descriptions of the parts are not included.

Finally, Bertrand (1935) briefly describes some characters of four larvae, thought to belong to Stenelmis, from Java. Only the antenna and mandibles are figured.

Comparative studies of the larvae, within a genus of Dryopidae, have not been made. The larvae of some genera still are unknown, but, when most of the larval types have been discovered and studied,

we may have a better understanding of the phylogeny of the entire family.

DESCRIPTION OF THE PUPA

Matheson (1914) gave us our only figure and description of the pupa of Stenelmis. According to this author:

"The pupa (*Stenelmis bicarinata* Lec.) is soft, white in colour, the thoracic segments, wing pads and legs being slightly dark in colour. This darkness deepens with the age of the pupa. Length, 3.4 mm.; width at base of wing pads, 1.2 mm.

"The head lies incurved under the prothorax, the developing mouth parts showing very distinctly. The eyes are small and almost black. The antennae lie in front of the eyes and extend under the pronotum, thus being concealed from the dorsal view. The wing pads are prominent.

"The pronotum is large and rather densely covered with fine colourless setae. The outer angles of the anterior margin each bear a long, curving spine, measuring .32 mm. The posterior outer angles, also, each bear a spine measuring .28 mm. These spines are yellowish-brown in colour. They support the pupa in its chamber, preventing it from coming in contact with the coarse grains of sand.

"The abdomen is composed of nine segments, the posterior margins on the dorsal side being strongly elevated into narrow ridges. These ridges are clothed with numerous short setae. The ninth segment bears on its dorsal side two curving, stout cerci, measuring .4 mm. in length. The cerci almost completely conceal the segment from which they arise. The pupa rests on its back in the pupal chamber. By the aid of the prothoracic spines and cerci together with the numerous short setae arising from the raised ridges of the abdomen, injury from the roughened walls of the pupal chamber is avoided. The posterior margins of the wing pads and the legs are also provided with many short setae."

GEOGRAPHICAL DISTRIBUTION

The family Dryopidae is not a large one, there being some 600 species representing approximately 80 genera known from the entire world. Their distribution extends to all of the continents, and nearly every locality, through the tropical and temperate zones, is productive of from one to many species. The greater number of the known species appear to come from the Oriental region, and from the East Indian group of islands. In a number of instances a genus may be confined to a definite region. The genera Pachelmis Fairm., Helminthocharis Grouv., Lophelmis Fairm, and a number of others are recorded only from Africa and Madagascar. Phanocerus Sharp is known only from North and South America and the West Indies. However, other genera are more widely distributed and not confined to a limited region. Dryops Oliv. is found in Europe, Asia, North and South America, and Africa. Thus, it might be said to be found on all continents with the possible exception of Australia.

The genus Stenelmis Duf. is one of the larger genera of the family, sixty-nine species having been described. Nearly one half of the species are from the Oriental region and the East Indian Archipelago. Sumatra, alone, has ten species. The United States is second in importance to the Orient with one third of the species. The rest occur over wide areas, three recorded from Europe, ten from Africa, and one each from Damascus, French Guiana, Borneo, and Costa Rica. It is of interest to note that one species, *S. minuta* Grouv., has been recorded both from Sumatra and Java.

Although there are, no doubt, many more new species to be discovered from one region or another, this distribution suggests that the genus may have arisen in the Orient.

In the United States the species of Stenelmis, with one exception, are distributed east of the 100th meridian from Canada south to Florida and Texas. *S. crenata* (Say) is distributed over the whole of the eastern United States from Quebec to Texas. On the other hand, *S. sexlineata* Sand. is, apparently, a middle western form, having been found only in Kansas and Texas. Some of the species occur in large numbers in small areas with an occasional specimen found in other localities. This is especially true of *S. lateralis* Sand., which is abundant in the streams of the Ozark Mountain region. A few specimens have been taken in Pennsylvania; Virginia; Tennessee; and Ireland and Lucedale, Miss.

Until more is known of the biology of this genus, it would be out of place to generalize regarding the habitat preferences of the various species. However, some of the species seem to prefer clear and cold streams; others muddy and warm ones. Other species are found in both. Two species, *S. quadrimaculata* Horn and *S. douglasensis* Sand., have been found in lake water and, from available information, they seem to be confined to this habitat.

In the great expanse between the 100th meridian and California, no species of this genus has been recorded, although considerable collecting has been done. However, *S. nubifera* Fall, our only western species, is distributed along the Pacific coast from Southern California to Oregon.

GEOLOGICAL DISTRIBUTION

A very few fossil Dryopidae or Psephenidae have thus far been recorded. Apparently the first fossil Dryopid to be made known was *Dryops* (Parnus) *prolifericornis* Fab. from the Pleistocene of Galicia. This species, identified in 1894, was associated with the recent species *D. prolifericornis* Fab. of Europe, which is now rec-

ognized as a synonym of *D. auriculatus* Geoffr. In 1911 Wickham recorded *Dryops eruptus* (now assigned to the genus Helichus) from the Florisant. The following year, he named *Dryops tenuior* (also placed with Helichus), and named and described the genus and species, *Lutrochites lecontei,* both species of which came from the Florisant. The first Psephenid, made known in 1911, was *Psephenus lutulentus* Scudder, described from the Florisant of Colorado. Concerning this species, Scudder says, "The species described below, from the Oligocene of Colorado, is the only extinct form of this family yet known." The Florisant of the Miocene is the correct horizon, no doubt, rather than the Oligocene. This constitutes virtually all that has been made known of fossil Dryopidae and Psephenidae.

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DESCRIPTION OF THE GENUS STENELMIS

Elongate, convex or subdepressed species. Head retractile and protected beneath by the prosternal lobe. Antennae eleven-segmented, the segments gradually broader toward the distal one, the basal one or two wider and more rounded than succeeding ones. Maxillary palpi four-segmented, the labial palpi three-segmented. Mandibles bidentate at apex. Eyes denuded. Pronotum usually quadrate or longer than broad, convex, with a median longitudinal sulcus, and on either side a rounded or elongate basal tubercle. A

tubercle in front of the basal one generally rounded or elongate, though occasionally indistinct anteriorly from the general surface of pronotum. Apical angles of pronotum prominent. Elytra punctate-striate with the third interval usually elevated at base, the sixth elevated and usually carinate for nearly its entire length. Front coxae rounded, without trochantin, widely separated by posterior lobe of prosternum which fits against a groove in the mesosternum. Middle coxae rounded, more widely separated than the prosternal coxae. Posterior coxae transverse, dilated internally, with their separation less than that of the middle coxae. Ventral abdominal segments five, the apical one with its apex more or less emarginate. Legs slender, the hind legs longer than either the middle or anterior ones. Tarsi five-segmented, the last segment generally longer, but never more than slightly shorter than the four preceding segments combined. In our species, anterior tibiae without brush of tomentum on inside of apical half.

SECONDARY SEXUAL CHARACTERS OF STENELMIS

In all of our species the males have been found to possess a spinous ridge or a row of spinules on the inside of the middle tibia. The spines are variable in number within the species. They usually extend posteriorly for a short distance from near the middle of the tibia. The females have the inside of the middle tibia smooth. Both middle and hind tibiae of *Stenelmis nubifera* Fall have been found to possess the same type of spination. Another character, of sexual importance, which has been found in at least one species, *Stenelmis quadrimaculata* Horn, is a white labro-clypeal band. This membranous band is entirely absent in the males of the species, but very distinct in the females.

SPECIFIC CHARACTERS IN STENELMIS

In this genus, in which most of the species are closely related, the search for characters by which to segregate species has been a rather difficult task. Since no key has been published to include all of the known members of our fauna, a means was first sought to separate the species into groups. Inasmuch as all of our species, with one exception, are confined to the eastern half of the United States, a study was made of the Pacific Coast *Stenelmis nubifera* Fall to see if it presented any marked differences from those of the East. Examination shows that the first elytral stria of *Stenelmis nubifera* Fall is incomplete, and does not extend to the apex of the elytron. Furthermore, the granulations of the head, pro-

notum, and legs are conspicuously elongate, contrasted with the rounded granules of the other species. Other characters were also noted, such as the type of maculation, etc. One species was thereby eliminated, and study was then made of the remaining ones to see if they presented any group characters. An examination showed that they could be differentiated into two fairly well-defined groups, based upon the comparative length of the last tarsal segment with the four preceding segments combined.

The groups are accordingly designated as *Nubifera* group with one species; *Crenata* group with eleven species; and the *Sinuata-humerosa* group with fifteen species. The members of the *Crenata* group have the last tarsal segment no longer than the four preceding segments combined. Those of the *Sinuata-humerosa* group have the last segment distinctly longer than the combined length of the preceding four. The longer last segment invariably has the claws more robust.

Descriptions of the different species have been arranged, in this paper, in a logical manner and the scheme has been consistently followed throughout. After a species has been traced to its position in the key, it should be carefully compared with its description.

The following arrangement has been used in all descriptions:

Size. The total length of the species, indicated under size, may fall short of the total length of the pronotum plus elytra. This is explained by the fact that the pronotum is not in the same plane with the elytra, but is slightly deflexed. Measurements of the width are from the greatest width across the elytra.

Form and color. The form of Stenelmis may vary somewhat from one species to the next, but in degrees that make description difficult. In general, however, the range is from nearly subdepressed to convex. The body is usually slender, and with the sides of the elytra nearly or quite parallel.

Head. All of our species, except *S. nubifera* Fall, have a dark median longitudinal band on the head with two lighter bands, nearly of equal width, on the inside of the eyes. The bands may be indistinct if the specimens have the head covered with earthy matter. In several cases the color of the antennae and palpi aid in segregating certain species. The length of the antenna is helpful in certain groups. Several of the last antennal segments in many specimens are clothed with very fine, yellow hairs and a few stiff ones near the apices of these segments. This character has not been found of specific value, for the hairs may be present or absent within a series of a single species from one locality.

Pronotum. There is every gradation in the pronotum from one in which the median longitudinal sulcus or groove is very deep, with the sides nearly straight, to one in which the groove is barely evident. There is, likewise, much variation in the size and shape of the tubercles at base of pronotum between posterior angles and sulcus. In some species this tubercle is carinate posteriorly; in others the carina is obsolete. The tubercle immediately preceding the basal one is designated as the anterior tubercle and is variable to some degree. It is rounded and may be very prominent to inconspicuous. The oblique transverse impression separates the lateral tubercles in a varying degree and is occasionally deep immediately on the inside of the basal tubercle. Behind the anterior angle of the pronotum is a small, transverse ridge, continuous with the lateral margin of pronotum, and variable in its distinctness. In two species, *S. tarsalis* n. sp. and *S. concinna* n. sp., the anterior tubercle barely unites with this transverse elevation. In some species the crenation of the lateral margin of pronotum is better marked than in others, although this character seldom aids in the separation of closely related species. The pronotum, as well as the elytra, is covered with fine, usually close, and decumbent hairs. These appear to be more distinct on the margins of the median sulcus and the base of the third elytral interval. The pronotum is nearly always longer than wide, and especially so in the *Sinuata-humerosa* group. In *S. tarsalis* n. sp., however, the width is slightly greater than the length.

Elytra. The keys, to a great extent, are based upon the maculation of the elytra. Therefore, it is necessary to start with a specimen in clean condition, or nearly so. However, two species are known in which the elytra are entirely without spots or vittae. One species is known by the presence of six longitudinal vittae on the elytra. Other divisions within the two major groups have the humeral spot covering the umbone of the elytron, or the spot may be confined to the inside of the sixth elytral interval. When the vitta is divided into two spots, the basal one is termed the *basal spot*, the other is the *apical spot*. Rarely do individuals of the same species show every gradation between an entire vitta and one in which the spots are separate.

The first interval is designated, in this paper, as the one between the elytral suture and the first stria. In *Stenelmis nubifera* Fall the first stria is short, with the fourth interval elevated at base. The seventh interval is also elevated in this species. In all others of the

genus in our fauna the first stria continues to the apex of the elytron. The third interval is elevated at base in all but one or two of the remainder of our species. The sixth interval is always more or less carinate from the base for about five sixths of its length.

Venter. The apex of the last abdominal segment is always emarginate, although the emargination may be partially covered above by a thinner part of the segment. In *S. nubifera* Fall the width of this emargination is about twice that of the greatest width of the last tarsal segment. In all others the width may be less than, to but little more than, that of the tarsal segments. The value of this character is especially significant in such closely related species as *S. tarsalis* n. sp. and *S. concinna* n. sp. The color of the venter is variable and is of little importance. In perfectly clean specimens the venter is a beautiful irridescent blue.

Legs. The character of the last tarsal segment is of fundamental importance in the separation of our groups of Stenelmis. The *Sinuata-humerosa* group, in which the last segment is longer than the preceding four combined, has this segment more suddenly enlarged distally than in the *Crenata* group. The claws in the latter group are slender and much less robust than in the other group. In two species the lower margin of the last tarsal segment is triangularly produced. This margin in all other species is straight or but little produced. The color of the tibiae and tarsi is useful in separating some species. With exception of *S. douglasensis* n. sp. and *S. grossa* n. sp., all of the species in our fauna have the pronotum, venter, and legs granulate. The granulation of the femora refers to the larger ones on the outer surface. These are frequently intermixed with many fine granules. The hind tibiae are always longer than the middle and anterior ones. The anterior tibiae are longer or equal to the middle tibiae.

THE MALE GENITALIA OF STENELMIS

The genitalia of the males of Drypos, Helichus, Elmis, and a few other genera have been used to some extent in classification, but to the writer's knowledge, the genital structures of but one Stenelmis (*nevermanni* Hntn. 1935) have been figured and described for this purpose. Since some of the species of Stenelmis are difficult to segregate by external characters, a study of the male genitalia shows that this organ is of some importance. The genitalia are quite simple, consisting primarily of a large cylindrical basal piece, a median, and two lateral lobes. The bases of the lobes are inserted

for a short distance inside the posterior opening of the basal piece. The median lobe is longer than the lateral ones.

In our species of Stenelmis four general types of genitalia are represented: (1) lateral lobes of aedeagus without internal sinuation, (2) lateral lobes sinuate internally, median lobe without lateral processes, (3) lateral lobes sinuate, median lobe with lateral processes evenly rounded, and (4) lateral lobes sinuate, median lobe with lateral processes subangulate anteriorly. The first type is found in *S. nubifera* Fall and the remaining types are found among the species in the Eastern United States. It must be pointed out that the genitalia are not to be depended upon entirely for the identification of species, but should be used in conjunction with the keys and descriptions. For example, one type might be exhibited in each of our chief groups of Stenelmis and the resemblance between the genitalia of two species, each in a separate group, may seem close.

TECHNIQUE FOR DISSECTING MALE GENITALIA

The technique for extracting the genitalia is simple and is as follows: The male is determined by the presence of the small spines on middle tibiae, all labels are removed from the pin, and the specimen is immersed for several minutes, or as long as necessary, in a 5-10 percent hot alcohol solution. After the beetle is sufficiently relaxed, it is held between the thumb and forefinger; a small, curved dissecting needle is inserted between the last dorsal and ventral abdominal segments; and the genitalia and associated parts are removed. A few minutes' boiling in a weak solution (5-10 percent) of caustic potash, then washing in distilled water, will clear the structures sufficiently for study. It has been found very convenient to mount the genitalia below the dissected specimen upon a small celluloid slip with the genital parts immersed in a drop of commercial diaphane (euparol). Thus the genitalia is always with the specimen and is easily removed by dissolving the diaphane in ninety-five percent alcohol. The genitalia may also be mounted on glass slides in Canada balsam or diaphane and covered with a cover-slip. Another method is to put the genitalia in a drop of glycerine in a small vial which is of the size that it may be kept on the same pin with the dissected specimen. The pin is passed through the cork of the vial.

SYSTEMATIC TREATMENT

KEY TO GENERA OF DRYOPIDAE OF THE UNITED STATES

At the time of this writing, the world genera are in the process of being revised by Mr. Howard E. Hinton, Berkeley, Cal., after which this key may be subject to modification. No attempt is made to extend it beyond the limits of the United States, and for that reason it is applicable only to the forms within this region. It is given simply to show the relationship of Stenelmis to the other genera.

At present it is considered that the Dryopidae are divided into three subfamilies, as follows:

SUBFAMILIES OF DRYOPIDAE

1. Head not entirely retractile; anterior lobe of prosternum ill defined or absent; mouthparts exposed; posterior coxae dilated and partly protecting femora........... *Larinae*,
   Head usually retractile, usually protected beneath by prosternal lobe; mouth parts generally concealed.. 2
2. Anterior coxae, with transverse trochantin........................ *Dryopinae*,
   Anterior coxae globular, without trochantin........................ *Elminae*,

Larinae

Antennae clavate.. *Phanocerus*,
Antennae not clavate.. *Lara*,

*Dryopinae**

1. Body rounded; last segment of maxillary palpi hatchet-shaped............ *Lutrochus*,
   Body elongate, oval; last segment of maxillary palpi slender................ 2
2. Second segment of antennae produced into an earlike process................ 3
   Second antennal segment not thus produced................ 4
3. Antennae approximate; thorax with a deep-cut, sharp-edged, longitudinal line on each side.. *Dryops*,
   Antennae widely separated; thorax not as above................ *Helichus*,
4. Antennae distant.. *Pelonomus*,
   Antennae approximate.. *Throscinus*,

Elminae

1. Anterior tibiae without a patch of tomentum........................ *Stenelmis*,
   Anterior tibiae with tomentum.. 2
2. Antennae of less than 10 segments.. 3
   Antennae of 10 or 11 segments.. 4
3. Antennae 7-segmented.. *Macronychus*,
   Antennae 8-segmented.. *Zaitzevia*,
4. Maxillary palpi 3-segmented.. 5
   Maxillary palpi 4-segmented.. 6
5. Sublateral carinae present.. *Elmis*,
   Sublateral carinae absent.. *Narpus*,†

* The genus Oberonus Csy. has been omitted from the key to the Dryopinae. At the present time I am not of the opinion that it should be made distinct from Pelonomus until additional specimens are examined to verify the characters set forth by Casey. I have examined the type, and it is true that the structure of the intermediate coxae is radically different from Pelonomus. However, this may be no more than an imperfectly developed structure. The type of Oberonus is a male and the genitalia are exactly the same type as Pelonomus.

†This genus was incorrectly placed with the Dryopinae until its correct position was established by Hinton (Ent. Mo. Mag. Vol. 72, 1936, p. 57). I have examined the imperfect type of this species, and in addition, several perfect specimens. The type of antennae, as well as the globular anterior coxae, unmistakably place it in the Elminae.

6. Head free, prosternum not lobed in front .... *Ancyronyx*,
Head protected by prosternal lobe 7
7. Second elytral stria terminating at about basal one third of elytra .... *Elsianus*,
Second elytral stria complete or nearly so 8
8. Prothorax with a sublateral carina extending from base to apex 9
Prothorax without a sublateral carina or with a very short one 13
9. Median longitudinal groove or impression present 10
Median longitudinal groove or impression absent 11
10. Transverse impression on apical one third; two oblique subbasal impressions, *Microcylloepus*,
Transverse impression absent; no oblique subbasal impressions .... *Cylloepus*,
11. No transverse or other impressions between sublateral carinae .... *Limnius*,
Transverse impression present 12
12. Impression a little anterior of middle .... *Neoelmis*,
Impression median .... *Heterelmis*,
13. Sublateral carinae very short, from one third to one half the length of thorax, *Heterlimnius*,
Sublateral carinae absent .... *Simsonia*,

GROUPS OF STENELMIS

An examination of our species shows that they may be separated into three fairly well-defined groups as follows:

PAGE

1. First elytral stria incomplete, terminating shortly behind scutellum; granules of head and legs elongate .... *Nubifera* group, 661
First elytral stria complete from base to apex; granules of head and legs rounded. . 2
2. Last tarsal segment distinctly longer than the four preceding combined, the last segment usually suddenly dilated beyond the middle; tarsal claws comparatively robust, *Humerosa-sinuata* group, 684
Last tarsal segment never distinctly longer than the preceding segments combined, the last segment not as noticeably dilated; tarsal claws comparatively slender, *Crenata* group, 663

NUBIFERA GROUP

Stenelmis nubifera Fall

(Pl. LXXX, fig. 1; Pl. LXXXI, figs. 7, 19)

1901. *Stenelmis nubifera* Fall, Occ. Papers Cal. Ac. Sci. VIII, p. 238.

Size. Length, 2.15-2.7 mm.; width, .87-1 mm.

Form and color. Body elongate, nearly parallel, and only slightly wider behind middle, moderately subdepressed. Color deep reddish-brown with a broad basal testaceous area on elytra and another before the apex.

Head. Frontal band absent; head granulate with the granules rather large, longitudinally elongate, and separated laterally by their own transverse diameters. Antennae and palpi testaceous; the antennae distinctly longer than the pronotum.

Pronotum. Length, .62-.8 mm.; width, .73-.9 mm. Widest just behind middle, then gradually tapering to base; slightly narrowed before the rounded sides and sinuate before apex. Base of pronotum distinctly wider than apex. Entire surface moderately, closely, and evenly granulate; the granules rounded or elongate and separated

by less than their diameters. Median sulcus moderately deep, rather suddenly narrowed to the two posterior carinae before the scutellum. On each side of sulcus, two elongate tubercles, the posterior one of which is distinctly carinate before and extending to the base, the anterior one slightly prominent posteriorly and gradually reduced anteriorly to the surface of the disc. A slight depression on each side of the sulcus at base.

Elytra. Length, 1.6-2 mm.; width, .87-1 mm. Basal band occupying from one third to one fourth of the elytral length; the apical one about one fourth; suture darker to the apex. Elytral punctures very broad and deep basally, becoming reduced in size and depth toward the apex, on the apical band of which the punctures are nearly obsolete. First elytral stria incomplete, irregularly punctured, and extending to about one fifth of elytral length. Intervals nearly flat except the fourth which is slightly elevated and broadened at base.

Venter. Brown to dull grey. Granules of abdomen a little more elongate than on pronotum, becoming smaller and fewer towards apex. Apex of last abdominal segment with a very broad, shallow emargination which is usually equal to twice the greatest width of the last tarsal segment.

Legs. Hind tibiae, .65-.8 mm.; middle tibiae, .5-.65 mm.; anterior tibiae, .5-.65 mm. The last tarsal segment perceptibly shorter than the four preceding combined. All femora with granules rather close and longitudinally elongate. Middle tibia of male with a row of about ten evenly spaced small spines on the inside. Posterior tibiae with a similar set of spines nearly equally spaced and about fifteen in number. Femora, tibiae, and tarsi uniformly colored as the venter.

Notes on types. This species was described from a small series of specimens taken at Pasadena, Cal., October 31, 1892. I have examined the type and two paratypes.

Remarks and comparative notes. In the series of specimens examined, some variation has been noted in pronotal sculpturing; the width of the elytral bands is slightly variable, and there is some deviation in the ratio of the elytral length to the combined width. The demarkation between the bands is usually indistinct. In some specimens there is a tendency for the antennae to become darker toward the distal segment.

Notes on distribution. In addition to the types from Pasadena, Cal., the species has been examined from the following localities:

California: Siskiyou Nat. Forest, 7-14-35, R. H. Beamer.
Oregon: Bonneville, 7-3-35, R. H. Beamer.
Washington: Kalama, 7-4-35, R. H. Beamer.

Location of types. Type and paratypes in the collection of Mr. H. C. Fall, Tyngsboro, Mass.; one male paratype in the Francis Huntington Snow entomological collection, University of Kansas.

The distribution of this species has been extended for nearly 900 miles from the type locality.

CRENATA GROUP

KEY TO THE SPECIES OF THE CRENATA GROUP

PAGE

1. Each elytron with three longitudinal vittae......................*sexlineata* n. sp., 663
   Each elytron with not more than one vitta or elytron bimaculate................ 2
2. Humeral spot or vitta on inside of sixth interval............................ 3
   Humeral spot or vitta embracing umbone of elytra.......................... 5
3. Body very robust, and with the elytral spots or stripe wider, covering considerably more than the fifth interval; third elytral interval sharply elevated at base, *crenata* (Say), 665
   Body very elongate, with the elytral spots or stripe narrower, covering but little more than the fifth interval; third interval but slightly elevated at base and very short, 4
4. Length 2.85-2.9 mm.; median lobe of aedeagus* distinctly constricted at middle, *exigua* n. sp., 669
   Length 3.2-3.4 mm.; median lobe of aedeagus more nearly parallel...*beameri* n. sp., 671
5. Vitta very broad and covering nearly all of the inner space between the first and sixth intervals; vitta extending cephalad outside elevated apex of sixth interval, *lateralis* n. sp., 672
   Vitta narrower and never extending internally beyond the second or third intervals..6
6. Lower margin of last tarsal segment with a conspicuous angular process; species generally larger, 3.2-3.6 mm.. 7
   Lower margin of last tarsal segment without such a process; size usually smaller, 2.6-3.25 mm. 8
7. Apical abdominal emargination equal to width of last tarsal segment; tibiae testaceous only at base; pronotum generally rounded at sides........*concinna* n. sp., 674
   Apical emargination very inconspicuous and much less than width of last tarsal segment; tibiae and apices of femora testaceous......................*tarsalis* n. sp., 675
8. Basal tubercle of pronotum elongate and carinate.......................... 10
   Basal tubercle just perceptibly elongate and never carinate..................... 9
9. Each elytron distinctly bimaculate................................*knobeli* n. sp., 677
   Each elytron with an entire vitta...............................*bicarinata* Lec., 679
10. Elytra twice longer than its width, the legs entirely testaceous..........*exilis* n. sp., 680
    Elytra less than twice its width, the legs wholly or in some part dark..*mera* n. sp., 682

CRENATA GROUP

Stenelmis sexlineata n. sp.

(Pl. LXXX, fig. 2; Pl. LXXXI, fig. 23)

Size. Length, 3.2-3.6 mm.; width, 1.25-1.4 mm.

Form and color. Body elongate, parallel, moderately subdepressed. Color of elytra dark brown to black, and with three

* In this paper the term aedeagus is used in its less restricted sense.

longitudinal brownish testaceous vittae on each elytron. The vitta of the fourth and fifth intervals not extending laterad of the sixth interval to embrace the umbone.

Head. Granulations between eye and band rounded and generally separated from two to four times their own diameters. Antennae and palpi brownish-testaceous. Antennae distinctly shorter than pronotal length.

Pronotum. Length, 1-1.15 mm.; width, .95-1.12 mm. Disk of pronotum deep brown, but with posterior four fifths of sulcus and surface caudad of lateral oblique impression, grey. Widest behind middle, then tapering to base, but not suddenly. Rather sharply sinuate before rounded sides, then straight and nearly parallel to apex. Base of pronotum distinctly and conspicuously wider than apex. Granules between the median sulcus and the lateral tubercles; fine granules separated by nearly twice their own diameters. Median sulcus deep and extending from apical one fifth to base, sides parallel. An oblique impression on either side of median sulcus deep and clearly separating lateral tubercles; basal tubercle prominent, elongate, rounded anteriorly, distinctly narrowed and carinate posteriorly to base of pronotum. Anterior tubercle prominent, rounded, scarcely wider in any one diameter. Anterior angles of pronotum dull rufous.

Elytra. Length, 2.3-2.75 mm.; width, 1.25-1.4 mm. Each elytron with three longitudinal brownish-testaceous vittae. Vitta on inside of the sixth interval entire, not at all interrupted at middle, and occupying all of fourth and fifth intervals from base of elytron to apex; this vitta wider at base, narrowed toward middle, and again wider near the apex in conformity with combined widths of the intervals covered. First interval dark brown from behind scutellum to near apex; the second, including striae on either side, testaceous from near its base for three fourths the length of interval. A third vitta extending from the humerus on the outside of the sixth interval to the apex. First elytral stria continuous from elytral base to apex. Third interval distinctly raised at base and very convex.

Venter. General color grey, with the lateral and posterior margins of abdominal segments and median portion of metasternum brownish. Emargination of last abdominal segment just less than greatest width of last tarsal segment.

Legs. Hind tibiae, .9-1.12 mm.; middle tibiae, .75-.9 mm.; anterior tibiae, .85-.95 mm. Last tarsal segment distinctly shorter than the four preceding combined. Granules of hind femora sepa-

rated from two to four times their own diameters. All femora darker above than below, the apices of femora, tibiae, and tarsi brownish-testaceous.

Notes on types. Holotype male, 7-19-33; allotype female, 7-22-32; and numerous paratypes, Lawrence, Kan., collected at light from July 11 to August 5, 1930-1935, Milton W. Sanderson. Additional paratypes, Douglas county, Kansas, 9-24-1923, R. H. Beamer; August, E. S. Tucker; Olathe, Kan., 5-6-34, S. Clare; Manhattan, Kan., April 16, 1933, and 1934, C. W. Sabrosky; 3 miles north Onaga, Kan., 8-15-01, French creek; Belvidere, Kan., 7-2-04; Riley county, Kansas, September 29, C. D. Adams; Kan. (Coll. Hubbard and Schwarz); Texas, Belfrage; Canyon, Tex., 7-9-33, W. Benedict. Types and paratypes deposited in the Francis Huntington Snow entomological collection, University of Kansas. Paratypes in the Harvard College collection; in the collections of Dr. Paul N. Musgrave, Fairmont, W. Va.; and Mr. C. W. Sabrosky, East Lansing, Mich.

Remarks and comparative notes. The present species is the only known one in this group which is six vittate, and is to be associated with *S. crenata* (Say). It is easily separated from this, and other related species, by the type of its maculation. The median lobe of the aedeagus is without lateral processes as in *S. crenata.* An occasional specimen shows very clearly the grey area between the basal pronotal tubercles as in some specimens of *S. crenata* and *S. beameri* n. sp.

Stenelmis crenata (Say)

(Pl. LXXX, fig. 3; Pl. LXXXI, fig. 20)

1824. *E. crenatus* Say. App. Vol. II, Keating's Exp. to source of St. Peters Riv. under Maj. Long, Phila., p. 275.

1859. *Stenelmis sordida* Motschulsky. Etudes Entomologiques 8 me année 1859 Helsingfors, p. 51.

1869. *E. crenatus* Say. A description of the insects of North America, by Thomas Say, edited by John L. LeConte. Vol. I, p. 181 (contains original description).

ORIGINAL DESCRIPTION

"Thorax with four elevated lines; each elytrum with two dull rufous spots.

"Inhabits Pennsylvania.

"*Parnus crenatus?* Knoch in Melsh. Catal.

"Body blackish-brown; front with two dilated, cinereous, longitudinal lines; antennae and mandibles rufous; thorax with four obtuse, elevated, longitudinal lines; two intermediate ones nearly confluent at each end; lateral ones more distant, slightly interrupted

behind the middle; elytra with striae of dilated impressed punctures: an elevated line from the humerus terminates rather before the tip; another elevated line nearer the margin also originates at the humerus and becomes obsolete before the middle; a third elevated line originates at the middle of the base and also becomes obsolete before the middle of the elytrum; an oblong rufous spot on the humerus and another near the tip; tarsi dull rufous.

"Length less than three twentieths of an inch."

WRITER'S DESCRIPTION

Size. Length, 3-3.35 mm.; width, 1.2-1.37 mm.

Form and color. Body generally very broad and robust, subdepressed, distinctly wider behind. Color of elytra dark brown to black, each elytron with two testaceous spots or with an entire vitta which is on the inside of the sixth interval.

Head. Granulations between eye and band rounded, separated from one to several times their own diameters. Antennae and palpi brownish-testaceous. Antennae distinctly shorter than pronotum.

Pronotum. Length, .87-1.1 mm.; width, .87-1.12 mm. Anterior angles and margin rufescent. Base of pronotum from posterior angles to anterior end of basal tubercle and all of disk between tubercles a light grey in color. Margins and posterior half of median sulcus generally of same color. Remainder of pronotum dark brown to black. Pronotum widest just behind middle, then distinctly rounded and narrowed to posterior angles; in some specimens, slightly sinuate before hind angles. Base of pronotum narrower than behind middle. Margins in front of rounded sides sinuate, then faintly inwardly curved to apex. Base of pronotum distinctly conspicuously wider than at apex. Granules between lateral tubercles and sulcus very fine and sparse, separated by several times their diameters. Median sulcus very deep, widest before middle, then narrowed behind. Sulcus extending posteriorly from apical one fourth or one fifth to base. Oblique impression on either side of median sulcus distinct and clearly separating lateral tubercles. Basal tubercle elongate, narrowed posteriorly, and distinctly carinate to base of pronotum; anterior tubercle prominent, a little longer than wide.

Elytra. Length, 2.12-2.37 mm.; width, 1.2-1.37 mm. Each elytron with a humeral and subapical spot or with spots very distinctly united into a vitta, but which is always on the inside of sixth interval. Vitta or spots usually covering fourth and fifth intervals with apex of vitta or subapical spot usually reaching to about one

half the distance between end of carina of sixth interval and apex of elytron. First elytral stria complete from base to apex. Third interval distinctly raised and rounded at base, the elevation extending a little beyond basal declivity. Elytral punctures deep on disk, then smaller toward apex, but never obsolete in apical region.

Venter. Grey to brownish with apical margins of abdominal segments usually lighter. Abdominal emargination very inconspicuous and considerably less than the greatest width of last tarsal segment.

Legs. Hind tibiae, .87-1 mm.; middle tibiae, .67-.85 mm.; anterior tibiae, .75-.9 mm. Last tarsal segment equal to the combined length of the four preceding. Granules of femora rounded, separated from once to twice their own diameters. Femora dark except apex, which is testaceous. Tibiae and tarsi testaceous, the tarsi slightly darker.

Notes on types. Since the original types of this species are lost, new types are hereby designated.

Neoholotype, neoallotype, and neoparatypes, Guthrie, Tenn., 7-26-34, M. W. Sanderson, collected in Red river. Additional neoparatypes from the following localities: Hull, Que., 27, VIII, 1931, W. J. Brown (Can. Nat. Coll.); Knowlton, Que., 12, VI, 8, VIII, 21, VIII, 1930, L. J. Milne (Can. Nat. Col.); Wakefield, Que., 7-VIII, 31 (Can. Nat. Coll.); Winchester, Va., 7-21-34, M. W. Sanderson, Hogue Creek; Buffalo, N. Y.; "Mass."; Romney, N. H., VII, 18, '30, Darlington; Plymouth, VIII, 20, 1925, Darlington; Freeville, N. Y., 6 V, 1915 (H. H. Knight Coll.); "Pa." (H. H. Knight Coll.); Biol. Field Sta., Ithaca, N. Y., X, 2-13 (H. H. Knight Coll.); The Cove, Ithaca, N. Y., X, 2, 1913 (H. H. Knight Coll.); Inlet Valley, Ithaca, N. Y., X-2, 1913 (H. H. Knight Coll.); Ithaca, N. Y. (H. H. Knight Coll.); Concordville, Md., 7-18-34, M. W. Sanderson; Alpena, Mich., Oct. 5, '08, Nason (C. A. Frost Coll.); the following neoparatypes from the collection of P. N. Musgrave: Greenbrier, Tenn., June 12, '31, Little Pigeon river; Fairmont, W. Va., Aug. 3, at light; Btn. Va.; Head and Marlinton, W. Va., July 13, Elk river; Mineral county, W. Va., July 20, Johnny Cake Run; Mt. Storm, W. Va., Aug. 19, 1930, Johnny Cake Run; Wardensville, W. Va., July 19 and August 23, at light, and in Moore's Run; Huntsville, Ala., 6-17, Dry Fork; Pocahontas county, W. Va., June 29, Minnehaha Springs.

Remarks and comparative notes. In his original description, Say states, "Inhabits Penn." LeConte (1852) subsequently mentions Niagara river and again Pennsylvania as localities from which speci-

mens were taken. Horn (1870), in regard to this species, states, "Our common eastern species easily known by its broader thorax with more strongly rounded sides. Disk is channeled and on each side three obtuse tubercles. Entire surface is opaque and its general aspect more depressed. Abundant in waters of Pennsylvania."

Since Say's types of *S. crenata* are apparently lost, the author has redescribed what he regards as this species, and has designated new types. An examination of specimens determined by LeConte and Horn as *S. crenata,* examination of material from the Niagara and Pennsylvania, and many additional specimens from a wide range of localities over the eastern United States, shows that we have one very common species which might easily have been that of Say.

An examination of the type female of *S. sordida* Mots. shows that it is the same species as *S. crenata.* Since the latter has priority by thirty-five years, *S. sordida* is to be dropped from our lists. The elytral spots are not evident in the type due to a thin incrustation of debris. The sordid aspect of the specimen no doubt suggested its name to Motschulsky. As indicated in the original description, his specimen was from Pennsylvania.

Hundreds of individuals of the present species have been examined from localities, as already indicated, and there is considerable variation within the series. There is some variation in size, relative proportions of length and width of pronotum, although the two measurements are generally the same, and in the character of the elytral maculae. Without exception, the macula is confined to the inside of the sixth interval, although the variation from an entire to a broken vitta is notable. In some specimens there is no indication of a separation of the humeral from the subapical spot.

Of the many specimens that have been examined, a single example has been found in which the lower margin of the last tarsal segment is prolonged nearly as in *S. tarsalis* n. sp. and *S. concinna* n. sp. The latter species, however, have the humeral spot covering the umbone. The present species may be separated from its closest ally, *S. beameri* n. sp., by its less elongate and more depressed form, the wider vittae, which in *S. beameri* usually cover no more than the fifth interval, and by its peculiar type of genitalia. The median lobe possesses two rounded lateral processes on the apical half, a character which is found in no other member of the *Crenata* group.

Notes on distribution. In addition to the specimens from various places designated as types, specimens from the following localities have been examined:

UNITED STATES:

Connecticut: Cornwall.
Massachusetts: Tyngsboro; Wellesley; Walpole; Plymouth.
Maine: Monmouth; Paris.
New York: Batavia; Staten Island.
Tennessee: "Tenn."
Maryland: "Md."
Pennsylvania: "Penn."; "Pen."; Lancaster.
Texas: Columbus.
District of Columbia: Washington.
Virginia: Fredrkbg.; Pennington Gap.
Michigan: Gd. Ledge; Cheboygan Co.
Kansas: Manhattan; Lawrence; Olathe.

CANADA:

Quebec: Hull; Knowlton; Knowlton's Landing; Wakefield; Otter Lake; Fairy Lk.; South Bottom; MacDonald; Covey Hill; Kazubazua.
Ontario: Bothwell; Normandale; Miner's Bay; Dundas; Walsh; Ronteau Pk.; Rideau R.; Ottawa.
New Brunswick: Boiestown.

Location of types. Neoholotype, neoallotype and neoparatypes deposited in the Francis Huntington Snow entomological collection, University of Kansas. Additional neoparatypes deposited in nearly all the collections given under acknowledgments.

Stenelmis exigua n. sp.

(Pl. LXXX, fig. 4)

Size. Length, 2.85-2.9 mm.; width, 1-1.1 mm.

Form and color. Body elongate, nearly parallel, scarcely wider behind, moderately subdepressed. Color deep brown to black. Each elytron with a narrow testaceous humeral spot and a subapical one. Humeral spot on inside of sixth interval.

Head. Granulations between frontal band and eye minute, rounded, and generally separated from two to four times their own diameters. Antennae and palpi testaceous. Antennae just perceptibly longer than pronotum.

Pronotum. Length, .87-.9 mm.; width, .75-.85 mm. Wider behind the middle, then a little narrowed to base. But faintly sinuate before hind angles. Margin convergent from rounded sides to apex, before which there is a double sinuation, the one immediately before the anterior angles smaller and less distinct. A little wider at base than at apex. Granules on either side of median sulcus at base fine and separated by two or three times their diameters. Median sulcus deep and extending from apical one fourth to base, the sides of sulcus slightly narrowed behind. Oblique impression on either side of median sulcus rather deeply separating lateral tubercles. Basal

tubercle rounded anteriorly and elongate, but scarcely distinctly carinate. Anterior tubercle rounded, scarcely prominent. Anterior angles and margin faintly to distinctly rufescent; remainder of pronotum dull black and in some individuals with a dull greenish cast.

Elytra. Length, 2.05-2.15 mm. Humeral spot narrow, occupying fifth interval, extending from behind humerus to about one fifth of elytral length. Subapical spot extending but little beyond apex of carina of sixth interval, covering all of fifth and a part of fourth intervals. First elytral stria complete from base to apex. Third interval faintly elevated at base. Strial punctures moderate, never obsolete near apex.

Venter. Dark through a light brown to dull grey or green with posterior and lateral margins of segments lighter. Apical emargination nearly equal to width of last tarsal segment.

Legs. Hind tibiae, .87-.9 mm.; middle tibiae, .7-.8 mm.; anterior tibiae, .75-.85 mm. Last tarsal segment a little shorter than the four preceding combined. Granules of femora (outer side) separated by no more than their own diameters, frequently less than. Femora uniformly dark except apex, which is testaceous. Tibiae and tarsi testaceous.

Notes on types. Holotype male, and allotype female, Polk, Ark., July 21, 1928, L. D. Beamer, collected at light. Paratype male, same data; paratype, female, "Mo.," Otto Lugger collection.

Remarks and comparative notes. This species is very closely related to *S. beameri* n. sp., and may be separated as follows: By actual measurement the pronotum and elytra are shorter in *S. exigua*, and the legs comparatively shorter. In the few specimens of the present species at hand, there is a fairly distinct double sinuation of side of pronotum in front of rounded side, while *S. beameri* has only the sinuation immediately in front of rounded sides. The sinuation before the posterior angle of pronotum is also more distinct in *S. exigua*. Reference to the male genitalia shows a much greater constriction of the median lobe in *S. exigua* than in *S. beameri*. This species is about the size of *S. exiles* n. sp., and *S. knobeli* n. sp., but differs from either by having the humeral spot of elytra on the inside of sixth interval.

Location of types. Holotype and allotype in the Francis Huntington Snow entomological collection, University of Kansas. One paratype in collection of Dr. Paul N. Musgrave. The second paratype deposited in the collection of the University of Minnesota, from which it was borrowed for study.

Stenelmis beameri n. sp.

(Pl. LXXX, fig. 5)

Size. Length, 3.2-3.4 mm.; width, 1.2-1.25 mm.

Form and color. Body elongate, nearly parallel, scarcely wider at all behind, moderately subdepressed. Color, black, each elytron with a narrow testaceous vitta, broadly interrupted at middle. Vitta not extending beyond the sixth interval.

Head. Granulations between frontal band and eye rounded and generally separated by a little more than their diameters. Antennae and palpi testaceous; antennae as long as pronotum.

Pronotum. Length, .95-1.05 mm.; width, .9-1 mm. Color, brown to dull black. Distinctly wider behind middle, then gradually tapering to base. Sinuate before the rounded sides, then convergently straight to apex. Base of pronotum distinctly wider than apex. Granules on either side of sulcus at base separated from slightly less to a little more than their own diameters. Median sulcus deep and extending from apical one fourth to base; sides parallel. An oblique impression on either side of the median sulcus clearly separating the lateral tubercles; the basal tubercle prominent, elongate, narrowed toward base of pronotum, and distinctly carinate; the anterior one prominent, rounded though very slightly longer in its longitudinal diameter. Anterior angles and margin and posterior angles, dull rufous.

Elytra. Length, 2.3-2.5 mm.; width, 1.2-1.25 mm. Humeral spot narrow, occupying no more than fifth interval, and extending from just behind the humerus to about one fourth or one third of remainder of fifth interval. First elytral stria complete. Elytral punctures moderately impressed, a little larger on disk, punctures becoming smaller toward apex, but never obsolete before reaching it. Third interval but slightly raised and rounded on basal declivity.

Venter. General color grey with lateral margins of metasternum and lateral and apical margins of abdominal segments testaceous. Emargination of last abdominal segment equal to the greatest width of last tarsal segment.

Legs. Posterior tibiae, 1-1.1 mm.; middle tibiae, .8-.87 mm.; anterior tibiae, .87-1 mm. Last tarsal segment shorter than the four preceding combined. Granules of femora rounded and separated by no more than their own diameters. Femora darker above and below; the apices and margins, tibiae; and tarsi brownish-testaceous.

Notes on types. Holotype male, allotype female, and numerous paratypes, Berryville, Ark., 7-4-34, R. H. Beamer, and M. E. Grif-

fith, collected at light. Additional material from Noel, Mo., 7-19-24, Beamer and Lawson, at light; Hollister, Mo., 7-28-34, M. W. Sanderson, Long Creek.

Remarks and comparative notes. In *S. beameri* n. sp. there is some variation in the length of the elytral spots, there being a tendency for union in the middle of elytron in some specimens, though there is always some clouding medially. The female allotype shows a greyish band at base of pronotum which extends from hind angles to anterior end of basal tubercles, then gradually curves to the opposite and basal angle of pronotum. This also occurs in some other specimens of this species. This coloration is quite characteristic of *S. crenata* (Say).

The present species keys out with *S. crenata* by its type of maculation, but is readily separated by its much more slender and elongate form. The maculation of *S. beameri* scarcely covers more than the fifth interval, the raised third interval at base is slight, compared with *S. crenata,* and the median lobe of the aedeagus of *S. beameri* is without lateral processes.

Location of types. Holotype, allotype, and paratypes deposited in the Francis Huntington Snow entomological collection, University of Kansas. Additional paratypes in the collections of Dr. Paul N. Musgrave, Fairmont, W. Va.; and Harvard College.

Stenelmis lateralis n. sp.

(Pl. LXXX, fig. 6; Pl. LXXXI, figs. 1, 15, 21)

Size. Length, 2.65-3 mm.; width, .95-1.1 mm.

Form and color. Body elongate, sides parallel, scarcely, if at all, wider behind than across humeri; moderately subdepressed. Color, black; each elytron with a very broad, yellow-testaceous vitta, which embraces umbone and extends on inside of sixth interval nearly to apex. Vitta also extending cephalad on lateral side of sixth interval.

Head. Granulations between eye and band, separated by about twice their diameters. Antennae and palpi yellow testaceous; the antennae slightly longer than pronotum.

Pronotum. Length, .83-.87 mm.; width, .75-.8 mm. Widest behind middle, then gradually tapering to base, before which there is a slight sinuation; lateral margin sinuate in front of rounded sides, then narrowed and straight to apex. Base slightly wider than apex. Granulations on either side of median sulcus at base separated by two to three times their own diameters. Sulcus moderately deep and extending from apical one third to near the base, perceptibly narrowed behind. Oblique impression on either side of sulcus, distinct

and clearly separating lateral tubercles. Basal tubercle elongate, narrowed toward base of pronotum, but not distinctly carinate; the anterior one rounded; entire anterior margin of pronotum rufescent.

Elytra. Length, 1.95-2.15 mm.; width, .95-1.1 mm. Vitta occupying all of inner space between first stria and sixth interval. Basal margin of elytra darker. Sutural stripe often a little broader toward apex. First elytral stria complete from base to apex. Third interval perceptibly raised and rounded basally. Elytral punctures large and deep, becoming smaller and shallower toward apex; punctures obsolete behind end of carina of sixth interval.

Venter. General color brownish to grey, the abdominal segments with posterior border testaceous. Apical emargination about equal to width of last tarsal segment.

Legs. Hind tibiae, .8-.85 mm.; middle tibiae, .65-.7 mm.; anterior tibiae, .65-.7 mm. Last tarsal segment distinctly shorter than four preceding combined. Granules of femora closely placed and usually separated by less than their own diameters. All femora darker above and below, the tibiae and tarsi testaceous.

Notes on types. Holotype male, allotype female, and numerous paratypes from Berryville, Ark., 7-4-34, R. H. Beamer and M. E. Griffith, collected at light. One paratype from Schellburg, Pa., VIII 16. Additional material from Hollister, Mo., 7-28-34, M. W. Sanderson, Long creek; Noel, Mo., 7-19-24, Beamer and Lawson, at light; Ireland, Miss., 7-7-34, M. E. Griffith, at light; Lucedale, Miss., June 22, P. N. Musgrave, White's creek; Winchester, Va., 7-21-34, M. W. Sanderson, Hogue creek; Clarksville, Tenn., 1915, at light.

Remarks and comparative notes. The present species is of particular interest, since it appears to be very abundant in several localities of the Ozark Mountain region in Arkansas and Missouri. The elytral vitta is always entire and is much broader than in any other known species of our fauna. The extension of the vitta cephalad on the outside of the carina of the sixth interval is very characteristic of this species. This character is found in an occasional specimen of *S. mera* n. sp., but the broader stripe with no indication of bimaculation will readily distinguish the two.

Location of types. Holotype, allotype, and paratypes in the Francis Huntington Snow entomological collection, University of Kansas. Additional paratypes in the collections of Dr. Paul N. Musgrave, Canadian national collection, Harvard College collection, C. A. Frost collection, and the collection of Harry H. Knight, Iowa State College.

Stenelmis concinna n. sp.

(Pl. LXXX, fig. 7)

Size. Length, 3.3-3.6 mm.; width, 1.3-1.5 mm.

Form and color. Body generally broad and robust, moderately convex, nearly parallel behind. Color, dark brown to dull black; each elytron with a testaceous spot on humerus which extends on inside of sixth interval, and an elongate subapical one.

Head. Granulations between eye and band rounded and separated by about twice their own diameters. Antennae and palpi brownish-testaceous. Antennae equal in length to pronotum.

Pronotum. Length, 1-1.1 mm.; width, .9-1 mm. Widest just behind the middle, then rounded to posterior angles. In some specimens slightly sinuate before hind angles. Margins in front of rounded sides narrowed and subparallel to apex. Before the middle of sides, a slight sinuation. Base of pronotum distinctly wider than apex. Granules between lateral tubercles and sulcus separated by about twice their own diameters. Median sulcus very deep, margin behind middle conspicuously raised and prominent. Inner sides of sulcus perpendicular in some specimens just before base; sulcus extending posteriorly from apical one fourth and slightly narrowed toward base. Oblique impression on either side of sulcus distinct and rather deeply separating lateral tubercles. Basal tubercle elongate, narrowed toward base and distinctly carinate to base, in some individuals acutely so; anterior tubercle elongate, about three times longer than its greatest width; anterior angles and margin rufescent.

Elytra. Length, 2.35-2.65 mm.; width, 1.3-1.5 mm. Small humeral spot embracing umbone, extending to and covering fourth interval at base and occupying only about one fifth of elytral length. Subapical spot extending from a point considerably behind the middle to a little beyond the apex of carina of sixth interval and occupying fifth and a part of fourth and sixth intervals. First elytral stria complete from base to apex. Third interval distinctly elevated and rounded at base, the elevation extending to near the posterior border of humeral spot. Elytral punctures deep at base and on disk and becoming shallow and smaller toward apex, never obsolete in apical region.

Venter. General color deep brown to grey, with apical margins of abdominal segments lighter. Last ventral abdominal segment almost wholly dark. Apical emargination conspicuous, equal to width of last tarsal segment.

Legs. Hind tibiae, 1-1.12 mm.; middle tibiae, .87-.95 mm.; an-

terior tibiae, .9-1 mm. Last tarsal segment shorter than the four preceding. Lower margin of apex of this segment prolonged into a conspicuous angulate process. Granules of hind femora rounded, very closely placed. Femora and tibiae dark in color, except base of tibia, which is brownish-testaceous. Tarsi brownish-testaceous.

Notes on types. Holotype male, allotype female and a number of paratypes, North River, N. Y., 7-7-34, M. W. Sanderson, collected in Hudson river. Additional paratypes, Wakefield, Quebec, May 29-Aug. 7, 1930-1932, W. J. Brown (Can. Nat. Coll.); Knowlton, Quebec, June 29-Aug. 8, 1928-1930, L. J. Milne (Can. Nat. Coll.); Bedford, Mass., VII-15-11 (C. A. Frost Coll.); mouth of Williams river, W. Va., July 10, 1933 (P. N. Musgrave Coll.); Marlin, W. Va., July 29, 1930, Greenbrier river (P. N. Musgrave Coll.); "N. C."

Remarks and comparative notes. In the large series of this species which the author has examined, all of the specimens show a distinct and wide separation of the humeral from the subapical spot, there being no indication of a union. A single specimen of this species from Marlin, W. Va., does not have the process of the tarsal segment prominent. However, the humeral spot covers the humerus, and the median lobe of aedeagus is without processes—characters which exclude it from being placed with *S. crenata* (Say).

This species is very closely related to *S. tarsalis* n. sp. by the presence of the angulate process on the lower margin of last tarsal segment, and by its type of elytral maculation. It may be distinguished from *S. tarsalis* by having the tibiae nearly completely dark; the apical abdominal emargination is equal to the tarsal width, and the humeral spot is much shorter than in *S. tarsalis*. The sides of the median lobe are nearly parallel in the present species.

Location of types. Holotype, allotype, and paratypes in the Francis Huntington Snow entomological collection, University of Kansas. Additional paratypes in the Canadian national collection, C. A. Frost collection and the collection of Dr. Paul N. Musgrave.

Stenelmis tarsalis n. sp.

(Pl. LXXX, fig. 8; Pl. LXXXI, figs. 13, 18)

Size. Length, 3.2-3.5 mm.; width, 1.25-1.5 mm.

Form and color. Very broad and robust, moderately convex, wider behind than across the humeri. Elytra black; each elytron with a small entire spot which covers humerus, and an elongate subapical one.

Head. Granulations between eye and band rounded, and generally separated by two to three times their own diameters. An-

tennae and palpi brownish-testaceous, antennae slightly shorter than pronotal length.

Pronotum. Length, .95-1.12 mm.; width, 1-1.2 mm. Widest considerably behind the middle, then rounded to posterior angle, before which there is a vague sinuation. Lateral margins narrower in front of rounded sides and nearly straight to apex; a very feeble sinuation about half way between rounded sides and the anterior angles. Base of pronotum distinctly wider than apex. Granules on each side of sulcus separated by from once to twice their own diameters. Median sulcus very deep and with lateral margins perpendicularly produced internally for nearly the entire length. Sulcus extending posteriorly from about the apical one fifth to near posterior margin of pronotum, nearly parallel-sided throughout its length. A distinct oblique impression on either side of median sulcus clearly separating lateral tubercles. Basal tubercle elongate, narrowed posteriorly, and distinctly carinate almost to basal margin of pronotum, anterior one elongate, nearly three times longer than its own width. Anterior margin of pronotum rufescent, more distinctly so at angles. A light greyish area between the basal tubercles.

Elytra. Length, 2.25-2.6 mm.; width, 1.25-1.5 mm. Small humeral spot embracing umbone, extending posteriorly on inside of sixth interval for about one fourth of elytral length. Spot usually not extending beyond fifth interval internally. Subapical spot extending from behind middle to a point slightly beyond end of carina of sixth interval. This spot embracing fifth and part of fourth intervals in this region. First elytral stria complete from base to apex. Third interval distinctly elevated and rounded on basal declivity. Elytral punctures very broad and deep on either side of third interval at base. Remaining punctures deep, but becoming shallow and smaller toward apex of elytron, never obsolete in apical region.

Venter. General color, grey to nearly light blue, sometimes iridescent, and with apical margins of abdominal segments and nearly the entire apical segment brownish-testaceous. Apical emargination of last segment inconspicuous, not more than one half the greatest width of last tarsal segment.

Legs. Hind tibiae, .87-1.12 mm.; middle tibiae, .75-.9 mm.; anterior tibiae, .82-.95 mm. Last tarsal segment shorter than the four preceding combined. Granules of hind femora separated by little more than their own diameters. All femora entirely grey in color except apices, which are lighter. Tibiae brownish-testaceous, but with tarsi just slightly darker. Lower margin of last tarsal segment prolonged into a prominent process.

Notes on types. Holotype male, allotype female, and a number of paratypes, Winchester, Va., 7-21-34, M. W. Sanderson, Hogue creek. Additional paratypes: Berryville, Ark., 7-4-34, R. H. Beamer, at light; Ottawa county, Okla., June 4, 1930, 7-30-34, M. W. Sanderson; Guthrie, Tenn., 7-26-34, M. W. Sanderson; Annadale, Va., 7-21-34, M. W. Sanderson; Lynchburg, Va., July 12, P. N. Musgrave, Flat creek; Burlington, W. Va., August 22, 1930, Patterson creek; Wardensville, W. Va., August 22, 1933, Moore's Run; July 19, Moore's Run, and at light; Romney, W. Va., Aug. 22, 1930, South branch Potomac; Maysville, W. Va., Aug. 19, 1933, Lunice creek; Pocahontas county, W. Va., July 31, 1930, Minnehaha Springs; Franklin, W. Va., Aug. 9, 1933, Thorn creek; Clifton Forge, Va., July 13, Dunlap creek, P. N. Musgrave, at light; Batavia, N. Y., 7 Sept., 1915, and 8 Sept., 1916, H. H. Knight; Ottawa, Ontario, 14, VIII, 1912, G. Beaulieu; Ottawa, Canada, 15, VIII, 1912, G. Beaulieu.

Remarks and comparative notes. In the type there is a prominent post-coxal elevation on the first abdominal segment, but which is less conspicuous in other specimens. This character is also found in other species, but usually to a less marked degree. The anterior and the posterior lobes of the prosternum are brownish-testaceous, a variable characteristic of this species.

This species and *S. cincinna* n. sp. are our largest forms of Stenelmis in which the umbone is covered by the humeral spot. They might easily be confused with each other, both species possessing the same type of elytral maculation. In addition, they have the lower margin of the last tarsal segment prolonged into a prominent process. The present species is to be separated from *S. concinna* by its less conspicuous abdominal emargination, by its entirely testaceous tibiae, and by the shape of its aedeagus. The sides of the median lobe are distinctly sinuate, and not straight and nearly parallel as in *S. concinna.*

Location of types. Holotype, allotype, and paratypes in the Francis Huntington Snow entomological collection, University of Kansas. Additional paratypes in the collection of Dr. Paul N. Musgrave, H. H. Knight collection, and Canadian national collection.

Stenelmis knobeli n. sp.

(Pl. LXXX, fig. 9)

Size. Length, 2.75-3 mm.; width, 1-1.05 mm.

Form and color. Body elongate, moderately subdepressed, but little wider behind. Color of elytra deep brown approaching black.

Each elytron with a humeral spot which embraces the umbone, and a subapical spot.

Head. Granules between eye and band separated by a little more than their own diameters. Antennae and palpi testaceous, the palpi lighter. Antennae equal to pronotal length.

Pronotum. Length, .85-.87 mm.; width .8 mm. Wider behind the middle, then conspicuously narrowed, but scarcely sinuate before hind angles. Convergent from rounded sides to apex, the sides distinctly emarginate at middle. A little wider at base than apex. Granules on either side of median sulcus at base fine, rather conspicuous and separated by their own diameters. Median sulcus shallow, sides nearly parallel, extending from apical one third to apex of basal declivity. Oblique impression on either side of median sulcus rather shallowly separating lateral tubercles. Basal tubercle broadly rounded, perceptibly elongate, and not at all carinate behind. Anterior tubercle rounded, not at all prominent. Anterior angles and margin of pronotum rufescent, the remainder of pronotum dull black.

Elytra. Length, 2-2.25 mm. Humeral spot covering umbone and most of fourth and fifth intervals at basal one fifth. Subapical spot elongate, covering most of third, fourth and fifth intervals, extending obliquely inside to the first stria which it follows nearly to elytral apex. Subapical spot extends cephalad on the outside of carnia of sixth interval, becoming fainter near the middle of side of elytra. First elytral stria complete from base to apex. Third interval not at all elevated at base. Strial punctures moderately large, less so apically, but never obsolete near apex.

Venter. Light brown to dull grey, posterior margins and last abdominal segments lighter. Apical emargination nearly equal in width to last tarsal segment.

Legs. Hind tibiae, .85-.9 mm.; middle tibiae, .7-.75 mm.; anterior tibiae, .75-.8 mm. Last tarsal segment equal to the four preceding combined. Granules of femora (outer side) prominent and separated by much less than their own diameters. Femora nearly uniformly dark except at apex. Tibiae and tarsi testaceous.

Notes on types. Holotype male and allotype female, Hope, Ark., July 28, 1932, L. Knobel.

Remarks and comparative notes. According to the key this species is associated with *S. bicarinata* Lec. by the character of the basal tubercle of pronotum. Reference to my description of *S. bicarinata* will show that *S. knobeli* is considerably smaller, and each elytron is bimaculate. It bears its closest resemblance, however, to *S. exilis*

n. sp., both in size and general appearance. From *S. exilis* it may easily be distinguished by the absence of basal elevation of third elytral interval, the absence of posterior carination of basal tubercle of pronotum, by its darker femora, and by differences in the median sulcus of pronotum. *S. exilis* lacks the extension of the posterior elytral spot on outside of sixth interval found in the present species. The pronotum is a little narrower in proportion to its length than in *S. exilis*.

Location of types. Types located in the collection of Dr. Paul N. Musgrave, Fairmont, W. Va.

Stenelmis bicarinata Lec.

(Pl. LXXX, fig. 10; Pl. LXXXI, figs. 6, 17)

1852. *S. bicarinatus* LeConte, Proc. Ac. N. S. Phila. VI. p. 44.

Size. Length, 2.8-3.25 mm.; width, 1.1-1.25 mm.

Form and color. Body elongate, sides of elytra nearly parallel, convex. Color of elytra dark brown to black, each elytron with an entire vitta covering humerus and extending inside of sixth interval to near the apex.

Head. Granulations between eye and band rounded, generally separated from two to four times own diameters. Antennae and palpi light brownish-testaceous; antennae as long as or slightly longer than pronotum.

Pronotum. Length, .85-1 mm.; width, .8-.9 mm. Disk of pronotum grey and usually with blue or greenish reflections. Widest behind the middle, then convergent to base, only a faint indication of a sinuation before the angle. Usually slightly sinuate before rounded sides, then convergent and straight to apex. Base of pronotum wider than apex. Granules between basal tubercle and sulcus separated from one to three times their own diameters. Median sulcus moderately deep, inner sides only occasionally perpendicular and usually gradually sloping from margins of sulcus. Sulcus extending posteriorly from about apical one fourth to near the base, somewhat convergent on basal pronotal declivity. A moderately distinct oblique impression on either side of median sulcus shallowly separating lateral tubercles. Basal tubercle rounded, perceptibly elongate, and never carinate; a rather deep impression on the inside of basal tubercle about one third from base of pronotum. Anterior tubercle rounded, not at all prominent. Anterior angles and margin rufescent.

Elytra. Length, 2.15-2.45 mm.; width, 1.1-1.25 mm. Vitta embracing umbone, extending on the inside of sixth interval, covering all of the fourth and fifth, and terminating about half way between

end of carina of sixth interval and apex of elytron. First elytral stria complete from base to apex. Third interval very faintly to distinctly raised and rounded on basal declivity. Strial punctures prominent on disk, but becoming shallower and smaller toward apex, never obsolete.

Venter. General color bluish-grey with posterior margins of abdominal segments brownish-testaceous. Last abdominal segment in great part testaceous, with the emargination barely less than greatest width of last tarsal segment.

Legs. Hind tibiae, .88-1 mm.; middle tibiae, .75-.85 mm.; anterior tibiae, .8-.9 mm. Last tarsal segment shorter than the four preceding combined. Granules of femora usually separated by less than their diameters. Femora and tibiae grey except bases and apices, which are brownish-testaceous. Tarsi testaceous.

Notes on type. The type of this species from Ohio has been examined.

Remarks and comparative notes. This species is closely related to *S. mera* n. sp., from which it may be easily separated by its greater length, and by having no posterior elevation of the basal tubercles of pronotum. In addition there is no tendency toward quadrimaculation which is often found complete in *S. mera.* The median lobe of the aedeagus is more acute and parallel in *S. bicarinata* Lec. than in *S. mera.*

Notes on distribution.

KANSAS: Lawrence, June 4-Aug. 7, 1930-1935, M. W. Sanderson and L. S. Henderson; Saline county, July 7, 1925, R. H. Beamer; Woodson county, July 31, 1923, Beamer and Lawson; Riley county, Marlatt and J. B. Norton (Kansas State College collection).

TEXAS: "Tex." Belfrage (Harvard College collection); several additional specimens labeled "Tex." (Harvard College collection); "Tex.," May (W. Knaus collection); "Tex." (Univ. of Minn. collection); Camp San Saba, 5-28-04 (W. Knaus collection).

NEW JERSEY: "N. J." (W. Knaus collection); "N. J." (C. A. Frost collection).

NEW YORK: Ithaca, July 10, 1901 (H. H. Knight collection).

VERMONT: Bennington county, July, 1894 (H. H. Knight collection).

PENNSYLVANIA: "Penn." (Harvard College collection.)

Location of types. Type in the LeConte collection, Harvard College.

Stenelmis exilis n. sp.

Size. Length, 2.8-3 mm.; width, 1-1.1 mm.

Form and color. Body elongate, moderately subdepressed, a little

wider behind. Color of elytra deep brown. Each elytron with a humeral spot which embraces the umbone, and a subapical spot.

Head. Granules between eye and band separated by their own diameters. Antennae and palpi yellow-testaceous. Antennae equal to the pronotal length.

Pronotum. Length, .85-.87 mm.; width, .82-.87 mm. Wider behind middle, then conspicuously narrowed and slightly sinuate before hind angles. Convergent and nearly straight from rounded sides of apex, distinctly sinuate at middle. Wider at base than apex. Granules on either side of median sulcus at base very fine and inconspicuous. Median sulcus deep, the sides nearly parallel, extending from apical one fourth to base. A rather deep oblique impression on either side of median sulcus, clearly separating lateral tubercles. Basal tubercle rounded, prominent, elongate, and distinctly carinate behind; anterior tubercle rounded, prominent. Anterior angles and margin of pronotum rufescent.

Elytra. Length, 2.05-2.12 mm.; width, 1-1.1 mm. Humeral spot covering umbone and most of fourth and fifth intervals at basal one fifth; subapical spot elongate and terminating a little beyond the carina of sixth interval, and also covering most of fourth and fifth intervals. First elytral stria complete from base to apex. Third interval elevated only on basal declivity. Elytral punctures large and deep, never obsolete apically.

Venter. Light brown to dull grey and usually with posterior half of abdominal segments lighter. Apical emargination equal in width to last tarsal segment.

Legs. Hind tibiae, .77-.87 mm.; middle tibiae, .62-.7 mm.; anterior tibiae, .65-.77 mm. Last tarsal segment equal to four preceding combined. Granules of femora separated by no more than their own diameters. Femora and tibiae uniformly testaceous, the tarsi but little darker.

Notes on types. Holotype female and two paratype females, Berryville, Ark., 7-4-34, R. H. Beamer, collected at light.

Remarks and comparative notes. This species shows a striking resemblance to some of the smaller specimens of *S. beameri* n. sp., but is at once separated by having the humeral spot covering the umbone, and by the legs which are entirely testaceous. In *S. beameri* the apical one fourth only of the femur is testaceous, the tibia of the same color.

Location of types. Types deposited in the Francis Huntington Snow entomological collection, University of Kansas.

Stenelmis mera n. sp.

(Pl. LXXX, fig. 11; Pl. LXXXI, fig. 22)

Size. Length, 2.6-2.85 mm.; width, 1-1.2 mm.

Form and color. Body elongate, moderately convex. Sides of elytra parallel and scarcely wider behind. Color of elytra dark brown to black; each elytron with an entire vitta which embraces the umbone and extends on the inside of sixth interval nearly to apex; or vittae interrupted at middle to appear or nearly to appear quadrimaculate.

Head. Granulations between eye and band rounded, generally separated from one to three times their own diameters. Antennae and palpi light brownish-testaceous; antennae longer than pronotum.

Pronotum. Length, .8-.85 mm.; width, .8-.9 mm. Disk of pronotum dark brown to grey and usually with a darker fuscous area between basal tubercles; this frequently extending cephalad on either side of median sulcus. Widest behind middle, then convergent and straight to base. Slightly sinuate before rounded sides, then convergent and nearly straight to apex. Granules on inside of basal tubercles separated from once to twice their diameters. Median longitudinal sulcus deep; the inner sides, especially near base, perpendicular. Sulcus extending posteriorly from apical one fourth to base, somewhat narrowed before basal declivity. A distinct oblique impression on either side of median sulcus distinctly separating lateral tubercles. Basal tubercle rounded anteriorly, narrowed and elongate toward base of pronotum and distinctly carinate; anterior tubercle rounded, scarcely prominent. Anterior angles and margin rufescent.

Elytra. Length, 1.9-2.1 mm.; width, 1-1.2 mm. Vitta embracing umbone and extending on inside of sixth interval, usually covering all of fourth and fifth intervals and terminating shortly before apex. Vitta always with a more or less distinct band or clouding medially. First elytral stria complete from base to apex. Third interval usually very distinctly raised at base. Elytral punctures large and prominent and becoming smaller toward apex, never obsolete.

Venter. General color grey or brownish, with posterior margins of abdominal segments light brownish-testaceous. Emargination of last abdominal segment slightly more than greatest width of last tarsal segment.

Legs. Hind tibiae, .75-.86 mm.; middle tibiae, .62-.75 mm.; anterior tibiae, .65-.8 mm. Last tarsal segment shorter than the four preceding combined. Granules on lower side of femora rounded,

separated by less than their diameters. Femora, except apex, gray; tibiae variable in coloration though usually brownish-testaceous.

Notes on types. Holotype male, allotype female, and eight paratypes, Guthrie, Tenn., 7-26-34, M. W. Sanderson, collected in Red river. Additional paratypes from East Homer, N. Y., 7-5-34, M. W. Sanderson, East river; Ithaca, N. Y., July 10, '01; North river, N. Y., 7-7-34, M. W. Sanderson, Hudson river; Eureka Springs, Ark., 7-4-34, R. H. Beamer; Schellburg, Pa., VIII, 16; "Penn.," (Otto Lugger Coll.); "N. C.," (H. H. Knight Coll.), (Otto Lugger Coll.); N. C., Mass.; Greenbrier, Tenn., June 12, '31, P. N. Musgrave, Little Pigeon river; South Bottom, Quebec, 16.6. 1928, G. H. Fisk (Can. Nat. Coll.); Knowlton, Quebec, 19.6. 1928, G. H. Fisk (Can. Nat. Coll.); Keyser, W. Va., 7-22-34, M. W. Sanderson, New creek.

From West Virginia, material has been collected by P. N. Musgrave from the following localities: Wardensville, July 19, at light; Great Cacpon, July 24, 1933, Cacpon river; Meadow Branch of Sleepy creek, July 23, 1933; Richmond, July 11, 1933; North Fork Cherry; mouth of Williams river, July 10, 1933; Franklin, August 9, 1933, Thorn creek; Maysville, August 19, 1933, Lunice creek; Romney, August 22, 1930, South Branch Potomac; Burlington, August 22, 1930, Patterson creek; Stony river, August 21, 1930; Pocahontas county, July 31, 1930, Minnehaha Springs; Big Spring creek, June 3; Fairmont, August 3; New creek, August 20, 1930.

Remarks and comparative notes. Very often specimens of *S. mera* n. sp. are found in which there is a testaceous spot on the outside of carina of sixth interval near its apex, but which is always short and continuous with the distal stripe. This character approaches that of *S. lateralis* n. sp., from which this species is easily separated by its much narrower elytral vitta; the vitta of *S. lateralis* occupies all intervals inside of the sixth except the first. The present species is more nearly related to *S. bicarinata* Lec., but is separated by its shorter form, the elongated and carinate basal tubercle, and the median clouding of elytral vitta which in some instances clearly separates the humeral from the subapical spot. In *S. bicarinata* Lec. the vitta is always entire with no indication of a median cloud. *S. mera* has been identified as *S. linearis* Zimm. in some collections. As indicated elsewhere in this paper, this species is a synonym of *S. humerosa* Mots. It is properly placed in the *Sinuata-humerosa* group, and not in the *Crenata* group, to which *S. mera* belongs.

Location of types. Holotype, allotype, and paratypes deposited

in the Francis Huntington Snow entomological collection, University of Kansas. Additional paratypes in the Canadian national collection, collections of Dr. Paul N. Musgrave; University of Minnesota; and Dr. Harry H. Knight, Ames, Iowa.

SINUATA-HUMEROSA GROUP

KEY TO THE SPECIES OF THE SINUATA-HUMEROSA GROUP

PAGE

1\. Femora punctulate and not at all granulate 2

Femora distinctly granulate 3

2\. Longitudinal vitta of elytra complete from base to apex; processes on median lobe of aedeagus evenly rounded .... *douglasensis* n. sp., 685

Each elytron distinctly bimaculate; processes on median lobe of aedeagus subangulate anteriorly .... *grossa* n. sp., 686

3\. Elytra immaculate 4

Elytra maculate or vittate 6

4\. Median band of head as wide as two lateral ones combined; length of body, 2.5 mm.; width, .87 mm .... *parva* n. sp., 688

Median band but little wider than either lateral one; length of body, over 2.7 mm.; width, over 1 mm 5

5\. Length, 3.25-3.4 mm.; processes of median lobe of aedeagus present and distinct, *fuscata* Blatch., 689

Length, 2.7-2.8 mm.; processes of median lobe nearly absent and very inconspicuous, *hungerfordi* n. sp., 690

6\. Humeral spot distinctly covering umbone 7

Humeral spot on inside of sixth interval 8

7\. Femora and tibiae entirely grey .... *humerosa* Mots., 692

Femora grey, tibiae testaceous .... *mirabilis* n. sp., 693

8\. Antennae or palpi, or both, dark brown to black 9

Antennae and palpi testaceous 11

9\. Last six or seven antennal segments nearly always shining black, the palpi testaceous, *antennalis* n. sp., 695

Palpi usually dark brown to piceous, the antennae nearly always lighter 10

10\. Length, 2.7-3.2 mm. Lateral processes about two thirds the width of median lobe of aedeagus .... *quadrimaculata* Horn., 696

Length, 2.4-2.65 mm., processes about one third the width of median lobe, *musgravei* n. sp., 698

11\. Sides of pronotum in anterior third sharply divergent .... *sinuata* Lec., 699

Sides of pronotum in anterior third parallel or convergent 12

12\. Process of median lobe of aedeagus absent or very inconspicuous 13

Process of median lobe present and conspicuous 14

13\. Elytral stripe present and entire; processes absent .... *decorata* n. sp., 701

Faint humeral and subapical spots; processes very narrow and inconspicuous, *hungerfordi* n. sp., 690

14\. Processes of median lobe evenly rounded 15

Processes subangulate anteriorly .... *vittipennis* Zimm., 702

15\. Lateral processes of median lobe as wide as lateral lobes near apex; body more convex, the vittae less distinctly marked .... *convexula* n. sp., 704

Lateral processes about one half the width of lateral lobe near apex; body less convex, vittae more distinctly marked .... *märkelii* Mots., 705

Stenelmis douglasensis n. sp.

(Pl. LXXX, fig. 12)

Size. Length, 3.35-3.6 mm.; width, 1.2-1.5 mm.

Form and color. Body elongate, convex, nearly parallel. Elytra black; each elytron with a distinct longitudinal vitta on inside of sixth interval.

Head. Granulations of head obsolete. Antennae and palpi light brownish-testaceous. Antennae distinctly shorter than pronotum.

Pronotum. Length, 1-1.1 mm.; width, .9-1 mm. Pronotum grey to dull black; the prominences lighter. Apical margin of pronotum not rufescent. Sides nearly parallel in basal half and with a distinct sinuation before the hind angles; the hind angles very prominent. Narrowed anteriorly, then nearly parallel or divergent in front. Pronotum as wide at base as width behind middle; frequently distinctly wider. Width at apex shorter than at base. Surface of pronotum indistinctly punctulate. Median longitudinal sulcus deeply channeled from apical one fifth to base, but little narrowed posteriorly. Oblique impression on either side of median sulcus very distinct, clearly separating lateral tubercles. Basal tubercle is rounded anteriorly and carinate behind. Anterior tubercle prominent and rounded.

Elytra. Length, 2.4-2.5 mm. Each elytron with an entire longitudinal vitta extending to a point about one third of the distance between apex of carina of sixth interval and apex of elytra; vitta occupying nearly all of fourth and fifth intervals. Occasionally the second and eighth intervals are faintly longitudinally vittate. First elytral stria complete. Third interval moderately elevated at base, the elevation extending only about one sixth of the elytral length. Elytral punctures moderately deep on disk and not entirely obsolete on apical declivity.

Venter. Dull green to grey or dull black. Apical abdominal emargination a little less than width of last tarsal segment.

Legs. Hind tibiae, 1.1 mm.; middle tibiae, .87-.9 mm.; anterior tibiae, .9-.95 mm. Last tarsal segment distinctly longer than preceding four combined. Granules of femora and tibiae replaced by minute punctures. Femora and tibiae of same color as venter. The tarsi, brownish.

Notes on types. Holotype male, allotype female, and six paratypes, Cheboygan county, Michigan, July 10, 1936, T. C. Lawrence. Collected on submerged chunks of wood in edge of water along east shore of Douglas Lake. Additional paratypes from Nottawa, Mich.,

Sept. 1, 1933, C. W. Sabrosky. Collected on old pieces of wood in 1 to 1½ feet of water in Sand Lake. According to notes of the collector, "this lake has no inlet or outlet, being fed entirely by underground springs."

Remarks and comparative notes. *S. douglasensis* n. sp. is closely related only to *S. grossa* n. sp. by the complete absence of distinct granules over the surface of the body. As in *S. grossa*, the granules are replaced by distinct punctures. It is distinguished from *S. grossa* by its entire longitudinal vittae and the evenly rounded lateral processes of the median lobe of aedeagus. This is one of the few species which, apparently, confines itself to the lakes of the North. In some examples the second and eighth elytral intervals are faintly testaceous for a part of their lengths.

Location of types. Holotype, allotype, and paratypes in the Francis Huntington Snow entomological collection, University of Kansas. Additional paratypes in the collections of Dr. Paul N. Musgrave, Harvard College, and University of Michigan.

Stenelmis grossa n. sp.

(Pl. LXXX, fig. 13)

Size. Length, 3.25-3.6 mm.; width, 1.25-1.4 mm.

Form and color. Body elongate, convex, nearly parallel. Elytra reddish-brown to dark grey; each elytron usually with a faint humeral and subapical testaceous spot. Humeral spot on inside of sixth interval.

Head. Granulation nearly absent between eye and band, but a small group of granules near posterior end of band. Antennae and palpi light brownish testaceous, the antennae considerable shorter than pronotum.

Pronotum. Length, 1-1.12 mm.; width, .9-1.05 mm. Disk of pronotum dull grey to deep blackish-grey, the anterior part of sulcus light fuscous. Apical margin of pronotum rufescent. Sides of pronotum parallel or divergent on basal half and without a sinuation before basal angles. Narrowed anteriorly about the middle, distinctly sinuate, then sides nearly parallel or usually distinctly divergent to apices. Pronotum as wide at the base as width behind the middle, often distinctly wider. Width at apex shorter than at base. Granules not evident on either side of base of median sulcus. Median longitudinal sulcus deeply channeled from about the apical one fourth to base, narrowed posteriorly. Oblique impression on either side of sulcus distinct, and clearly separating lateral tubercles.

Basal tubercle rounded anteriorly, narrowed and elongate posteriorly and usually distinctly carinate to near the pronotal base. Anterior tubercle prominent and rounded.

Elytra. Length, 2.37-2.75 mm.; width, 1.25-1.4 mm. Each elytron usually faintly bimaculate. Humeral spot on inside of sixth interval, usually occupying no more than the fifth interval at base, and extending along the interval only for about one fifth of its length. Subapical spot extending from about one third behind the middle of elytron to barely beyond end of carina of sixth interval. First elytral stria complete from base to apex. Third interval conspicuously elevated at base, the elevation ending posteriorly to about the end of humeral spot. Elytral punctures deep on disk and becoming finer posteriorly, never obsolete on apical declivity of elytra.

Venter. Light brown to grey, usually lighter posteriorly. Apical abdominal emargination less than width of last tarsal segment.

Legs. Hind tibiae, 1-1.15 mm.; middle tibiae, .8-.9 mm.; anterior tibiae, .87-1 mm. Last tarsal segment distinctly longer than preceding four combined. Granules of femora usually not evident. Femora and tibiae of same general color as venter, the tarsi light brownish.

Notes on types. Holotype male, allotype female and two paratypes, Ireland, Miss., 7-8-34, R. H. Beamer. Additional paratypes from Tallulah, La., VII-12-30, VII-13-30, and VIII-15-30, P. A. Glick; Beauregard parish, Louisiana, 8-18-28, J. G. Shaw; Green county, Mississippi, 3-3-1932, H. Dietrich, Gaines creek; Leaf, Miss., Mar. 3, 1932, H. Dietrich; Lucedale, Miss., 6-22, P. N. Musgrave; Hope, Ark., VII-1-32, L. Knobel, at light (C. A. Frost collection). The specimens from Tallulah, La., are from the Harvard College collection, that of C. A. Frost, and the Canadian national collection.

Remarks and comparative notes. This species, with *S. douglasensis* n. sp., occupies a unique position in the *Sinuata-humerosa* group by the complete absence of granules on the pronotum, legs, and remainder of the body. The granules in this species and its ally apparently are replaced by distinct punctures. *S. grossa* is distinguished from *S. douglasensis* by the bimaculate instead of vittate elytra, and by the shape of the processes on the median lobe of the aedeagus. In *S. grossa* the processes are subangulate anteriorly; in *S. douglasensis* the processes are evenly rounded. These are two of our largest species of Stenelmis.

Location of types. Holotype, allotype, and paratypes in the

Francis Huntington Snow entomological collection, University of Kansas. Additional paratypes in the Harvard College collection; Canadian national collection; collection of Dr. Paul N. Musgrave, Fairmont, W. Va.; and C. A. Frost, Framingham, Mass.

Stenelmis parva n. sp.

(Pl. LXXX, fig. 14)

Size. Length, 2.5 mm.; width, .87 mm.

Form and color. Body elongate, parallel, convex. Elytra entirely immaculate above, color black.

Head. Median longitudinal band as wide as the two lateral ones combined, the granulation between median band and eye irregular and indistinct. Antennae and palpi yellow testaceous. Antennae longer than pronotum.

Pronotum. Length, .75 mm.; width, .65 mm. Base of sulcus and on either side of basal tubercles, light grey; remainder of pronotum a dull, dark brown. Sides of pronotum very slightly rounded behind middle, a little convergent posteriorly and anteriorly to basal and apical angles; width at apex equal to width at base. Granules on either side of sulcus very fine and separated by twice their diameters. Median longitudinal sulcus distinct though not deep, the anterior limits indistinct; sulcus extending posteriorly from about the apical one third to near the base, the sides nearly parallel. Oblique impression on either side of median sulcus distinct and clearly separating lateral tubercles. Basal tubercle a little elongate, the anterior one fairly prominent and rounded.

Elytra. Length, 1.85 mm.; width, .87 mm. Elytra entirely immaculate, there being no trace of pale spots. First stria complete. Third interval but slightly elevated at base. Elytral punctures moderately large and deep on disk, never obsolete on declivity.

Venter. Blue-grey, the posterior margin of abdominal segments and an entire narrow stripe on the last segment, lighter. Apical emargination less than width of the last tarsal segment.

Legs. Hind tibiae, .75 mm.; middle tibiae, .62 mm.; anterior tibiae, .65 mm. Last tarsal segment longer than preceding four combined. Granules of femora separated by their own diameters. Femora and tibiae darker grey than venter. Tarsi and extreme apex of the tibiae reddish-brown.

Notes on types. Holotype male and one paratype, Latimer county, Oklahoma, 12-VII-1931, W. Fisher. Allotype female, Edna, Texas, 8-9-28, R. H. Beamer.

Remarks and comparative notes. *S. parva* n. sp. has a wider median frontal band on the head than in any other species examined. This species is associated with *S. antennalis* n. sp. and *S. musgravei* n. sp. by its small size, but is readily distinguished by the total absence of elytral spots. By this characteristic it would be placed with *S. fuscata* Blatch., from which it is separated by its much smaller size.

Location of types. Holotype and paratype in the collection of Dr. Paul N. Musgrave. Allotype located in the Francis Huntington Snow entomological collection, University of Kansas.

Stenelmis fuscata Blatchley

(Pl. LXXX, fig. 15)

1925. *Stenelmis fuscatus* Blatchley, Can. Ent. 57, p. 164.

Size. Length, 3.25-3.4 mm.; width, 1.15-1.25 mm.

Form and Color. Body elongate, convex, parallel. Color of entire upper surface a uniform dark brown without indication of spots on vittae.

Head. Granulations between eye and frontal band rather coarse and uneven. Antennae and palpi yellow-testaceous. Antennae usually conspicuously shorter than pronotum.

Pronotum. Length, 1-1.1 mm.; width, .9-.95 mm. Anterior angles and margin of pronotum rufescent. Sides parallel on basal half, sinuate before middle, then a little convergent and rounded to apex. A slight sinuation between hind angles and rounded sides of pronotum. Width at base of pronotum equal to that at middle. Narrower at apex than at base. Median sulcus moderately deep, distinct to just before the base, and extending posteriorly from about the apical one fourth. Oblique impression on each side of sulcus distinct and clearly separating lateral tubercles. Basal tubercle a little elongate, anterior one more rounded and conspicuous.

Elytra. Length, 2.37-2.5 mm.; width, 1.15-1.25 mm. Entirely immaculate above with no trace of spots. First elytral stria complete from base to apex. Third interval elevated at base. Elytral punctures moderate on disk, then smaller toward apex, never obsolete.

Venter. Very dull grey to light brown, the abdominal segments nearly uniform in color. Apical emargination about equal to width of last tarsal segment.

Legs. Hind tibiae, 1 mm.; middle tibiae, .85 mm.; anterior tibiae, .9 mm. Last tarsal segment longer than preceding four combined.

Granules of femora rounded, separated by their own diameters or less. Femora and tibiae of the same general color as venter. Tarsi light brown.

Notes on types. The type and paratype, from Royal Palm Park, Fla., 3-18-24, W. S. Blatchley, have been studied.

Remarks and comparative notes. The specimens of this species before me are remarkably uniform in size. *Stenelmis fuscata* Blatch. was the first truly immaculate species to be named from our fauna. It is closely related to *Stenelmis hungerfordi* n. sp., from which it may be separated by its comparatively large size, and by the very distinct lateral processes on the median lobe of the aedeagus. In *S. hungerfordi* these processes are only about one fourth the width of the lateral lobes.

Notes on distribution. In addition to the types, the following localities are represented in the material at hand: Fort Pierce, Fla., 8-7-30, R. H. Beamer, P. W. Oman; Lacoochee, Fla., 8-18-30, J. O. Nottingham; Hillard, Fla., 8-19-30, P. W. Oman; and Hillard, Fla., 8-31-30, J. O. Nottingham.

Location of types. Type in the collection of Prof. W. S. Blatchley. Paratype in the Francis Huntington Snow entomological collection, University of Kansas.

Stenelmis hungerfordi n. sp.

(Pl. LXXX, fig. 16)

Size. Length, 2.7-2.8 mm.; width, 1-1.1 mm.

Form and color. Body elongate, convex, parallel. Color of elytra black, each elytron usually with pale humeral and subapical spots; the humeral spot, if present, always on inside of sixth interval.

Head. Granulations between eye and band generally separated by twice their diameters. Antennnae and palpi yellow-testaceous. Antennae slightly longer than pronotum.

Pronotum. Length, .85-.9 mm.; width, .75-.8 mm. Color of pronotum dull grey to brown; the anterior angles and margin rufescent. Occasionally a little lighter betweeen basal tubercles. Sides nearly parallel, though a little convergent of base; sinuate before the middle, then sides parallel, or slightly divergent at apices, never convergent. Sides before the basal angles perceptibly sinuate. Width at base of pronotum nearly equal to width behind middle, narrower at apex than at base. Granules on either side of median sulcus separated by about twice their diameters. Median longitudinal sulcus moderately deep, convergent posteriorly, indistinct at ex-

treme base. Oblique impression on either side of median sulcus distinct, clearly separating lateral tubercles. Basal tubercle a little elongate, never carinate; anterior one a little less distinct and rounded.

Elytra. Length, 1.95-2.1 mm.; width, 1-1.1 mm. Usually entirely immaculate above, though occasionally a small, indistinct humeral spot on inside of sixth interval, and a faint subapical one. Spot, when present, covering no more than fifth interval. First elytral stria complete from base to apex. Third interval elevated at base. Elytral punctures large on disk, becoming rapidly smaller at apex, never obsolete on apical declivity.

Venter. Dull grey to light brown, the abdominal segments generally lighter on posterior borders. Abdominal emargination less than width of last tarsal segment.

Legs. Hind tibiae, .82-.87 mm.; middle tibiae, .7-.72 mm.; anterior tibiae, .75 mm. Last tarsal segment longer than preceding four combined. Granules of femora rounded and usually separated by a little less than their own diameters. Upper surfaces of femora and tibiae grey with lower surfaces light brown; tarsi a lighter testaceous.

Notes on types. Holotype male, allotype female and numerous paratypes, Lacooche, Fla., 8-18-30, J. O. Nottingham, collected at light. Additional paratypes from Ocala, Fla., 8-17-30, Paul W. Oman; Plant City, Fla., 8-15-30, J. O. Nottingham.

Remarks and comparative notes. This species is named after Dr. H. B. Hungerford, University of Kansas, who has aided me in many ways in my study of Stenelmis. *S. hungerfordi* n. sp. is closely related to *S. fuscata* Blatch., but is readily separated by its smaller size, the antennae are longer than the pronotum, and an occasional specimen shows a faint humeral and apical spot on each elytron. The processes on the median lobe of aedeagus are evenly rounded and no more than one fourth the width of the lateral lobe. In *S. fuscata,* the processes are fully one half the width of lateral lobe. Reference to the plate of genitalia will show other minor differences.

Location of types. Holotype, allotype, and paratypes in the Francis Huntington Snow entomological collection, University of Kansas. Additional paratypes in the collection of Dr. Paul N. Musgrave.

Stenelmis humerosa Mots.

(Pl. LXXX, fig. 17)

1859. *Stenelmis humerosus* Mots. Etudes Entomo. VIII, p. 50.
1869. *Stenelmis linearis* Zimm. Trans. Am. Ent. Soc. 11, p. 259.

Size. Length, 2.3-2.7 mm.; width, .95-1.1 mm.

Form and color. Body elongate, convex, nearly parallel. Color of elytra dark brown to nearly black; each elytron with an entire longitudinal vitta which may be somewhat separated on disk into a humeral and a subapical spot. Vitta or spot covering humerus at base.

Head. Granulations between eye and band rounded, separated by several times their own diameters. Antennae and palpi light brownish testaceous. Antennae equal in length to pronotum.

Pronotum. Length, .7-.75 mm.; width, .68-.75 mm. Entire median sulcus and from its anterior end to apex of pronotum fuscous. On either side of sulcus a fuscous triangular area extending from base of pronotum between sulcus and lateral tubercle to a point near middle of pronotum. A small fuscous spot near anterior angles of pronotum. Margins of sulcus and remainder of pronotum a dull yellowish-grey. These areas with granules moderate in size though nearly reduced to general surface, the granules separated by about twice their own diameters. Sides of pronotum nearly parallel in basal half, then slightly narrowed at middle and subparallel to apical angles. Width at base of pronotum nearly equal to that at middle, but slightly narrower at anterior angles than at base. Granules on either side of median sulcus nearly indistinct. Median sulcus moderate in depth, nearly obsolete on basal declivity and extending posteriorly from near apical one third. Oblique impression on either side of sulcus almost wanting and only perceptibly separating lateral tubercles. Basal and anterior tubercles not at all conspicuous and but little raised above the disk of pronotum.

Elytra. Length, 1.75-1.88 mm.; width, .95-1.1 mm. Each elytron with the vitta usually entire, though somewhat clouded at middle. Humeral part of vitta embracing umbone, covering fourth and fifth elytral intervals and extending to a point about half way between end of carina of sixth interval and elytral apex. First elytral stria complete from base to apex. Third interval scarcely, if at all, elevated at base. Elytral punctures deep on disk, then becoming much smaller on apical declivity though never obsolete.

Venter. Grey or greenish-grey with nearly all of posterior half of abdominal segments dull reddish-brown. Abdominal emargination equal to width of last tarsal segment.

Legs. Hind tibiae, .75-.8 mm.; middle tibiae, .65-.72 mm.; anterior tibiae, .65-.72 mm. Last tarsal segment distinctly longer than preceding four combined. Granules of femora generally rounded and very closely placed, separated by less than their diameters. Femora and tibiae entirely grey, the tarsi dark brown.

Notes on types. The type female of *S. humerosa* Mots., from Tennessee, and the type male of *S. linearis* Zimm. from South Carolina, have been examined. An examination shows them to be the same species. In 1870 Horn expressed an opinion that the two might be the same, although he had not seen the type of *S. humerosa.* Since *S. humerosa* has priority by ten years, *S. linearis* thereby becomes a synonym. The type of *S. humerosa* bears the following label: "29 Juni vole a la mandelle dans la chambre dans uni nuit organse. Alabam."

Remarks and comparative notes. The present species is closely related to *S. mirabilis* n. sp., but is easily separated from the latter by the testaceous instead of dark brown to black palpi. In addition the tarsi are not lighter at base as described for *S. mirabilis.*

Notes on distribution. In addition to the types, four specimens have been examined from the following localities: Md.: Offutts Isl., 16.7.16, Loomis and Barber Coll. D. C.: "D. C." Otto Lugger Coll. Mass.: Chicopee, July 20, W. Knaus Coll.

Location of type. The female type of *S. humerosa* Mots. is located in the Zoölogical Museum of Moscow, U. S. S. R. The type of *S. linearis* Zimm. is in the LeConte collection at Harvard College.

Stenelmis mirabilis n. sp.

(Pl. LXXX, fig. 18)

Size. Length, 2.7-2.9 mm.; width, 1.1-1.12 mm.

Form and color. Body elongate, convex, a little wider behind. Elytra dark to black. Each elytron distinctly bimaculate and never with the vitta entire. Humeral spot embracing umbone.

Head. Granulations between eye and band separated by about twice their diameters. Antennae brownish-piceous to black, lighter at base, the palpi piceous to black. Antennae slightly longer than pronotum.

Pronotum. Length, .86 mm.; width, .75-.77 mm. Pronotum usually dull grey to deep brown. Sides nearly parallel before the base, narrowed anteriorly to middle, sinuate, then straight to apex. A little narrower across the apex of pronotum than at base. Granules on either side of median sulcus at base separated by about twice

their diameters. Median longitudinal sulcus distinct, moderately deep, distinctly narrowed posteriorly, and extending from the apical one fourth nearly to base. Oblique impression on either side of median sulcus distinct and clearly separating lateral tubercles. Basal tubercle rounded and but little elongate. Anterior tubercle rounded, not prominent.

Elytra. Length, 1.95-2 mm.; width, 1.1-1.12 mm. Each elytron distinctly bimaculate, the vitta never entire. Humeral spot embracing the umbone, extending diagonally inside of the sixth interval, and usually covering a little more than the fifth interval for one fourth or one fifth of its length. Subapical spot about equal to the dark band separating it from the humeral spot. Subapical spot extending to a point a little beyond end of carina of sixth interval. First elytral stria complete from base to apex. Punctures moderately deep on disk, becoming smaller and very fine on declivity, though never entirely absent.

Venter. Dull brown to a blue-grey. Apical abdominal emargination about equal to the width of last tarsal segment.

Legs. Hind tibiae, .8-.85 mm.; middle tibiae, .62 mm.; anterior tibiae, .65 mm. Last tarsal segment distinctly longer than preceding four combined. Granules on hind femora separated by no more than their own diameter. Femora above grey, usually a light brown below at base; tibiae nearly entirely testaceous except extreme base and apices, which are colored as the femora. Tarsi dark brown to black, the basal two thirds of the last segment lighter.

Notes on types. Holotype male, allotype female, Cos. Cob. Ct. (H. H. Knight Coll.); one paratype, Cos. Cob. Ct. (W. Knaus Coll.); one paratype, "N. C." (Otto Lugger Coll.); and an additional paratype from Anderson, S. C. JI. S, P. N. Musgrave (P. N. Musgrave Coll.).

Remarks and comparative notes. This species is of nearly the same size and form of *S. humerosa* Mots., but is easily distinguished by its lighter tibiae and much darker tarsi. In *S. humerosa* the tibiae are of the same color as the femora. The cleaner examples of this species are very striking in their type of coloration of the legs and elytra.

Location of types. Holotype and allotype located in the Francis Huntington Snow entomological collection, University of Kansas. Paratypes in the W. Knaus collection now located at Kansas State College, Manhattan, P. N. Musgrave collection, and that of the University of Minnesota.

Stenelmis antennalis n. sp.

(Pl. LXXX, fig. 19)

Size. Length, 2.5-2.7 mm.; width, 1 mm.

Form and color. Body elongate, parallel, convex. Color of elytra deep brown to black. Each elytron with humeral and subapical testaceous or reddish spots which are always on the inside of the sixth interval.

Head. Antennae with the last six or seven segments nearly always black, the basal segments testaceous. Palpi testaceous. Antennae longer than pronotum.

Pronotum. Length, .75-.85 mm.; width, .65-.7 mm. Basal one third of pronotum and margins of median sulcus often dull grey, the remainder dull brown to black. Anterior angles and margin faintly rufescent. Sides rounded behind middle, a little convergent posteriorly; sinuate before the middle, then sides parallel to apex. Width at base of pronotum equal to width at apex. Granules on either side of median sulcus very fine and generally separated from two to several times their diameters. Median longitudinal sulcus very shallow, a little narrowed behind and extending from the apical one third or one fourth to near the base. Oblique impression on either side of median sulcus often indistinct and faintly separating lateral tubercles. Basal tubercle faintly raised and elongate, the anterior one but scarcely evident.

Elytra. Length, 1.85-1.95 mm.; width, 1 mm. Each elytron with a pale or reddish humeral spot and a subapical one which extends but little beyond apex of carina of sixth interval. Spots covering most of the fourth and fifth intervals, and never uniting to form an entire stripe. First elytral stria complete. Third interval only faintly elevated at base. Elytral punctures rather shallow on disk, moderate in size, and usually extending to apex, though becoming much finer and occasionally obsolete on declivity.

Venter. Dull brown to grey, the posterior margin of abdominal segments usually lighter. Apical emargination equal to width of last tarsal segment.

Legs. Hind tibiae, .75 mm.; middle tibiae, .6-.62 mm.; anterior tibiae, .62-.64 mm. Last tarsal segment longer than preceding four combined. Granules of femora separated by a little less than their own diameters. Femora of same general color as venter. Tibiae and tarsi a little lighter.

Notes on types. Holotype male, Lucedale, Miss., Mar. 1, 1932, H. Dietrich (P. N. Musgrave Coll.); allotype female, Hilliard, Fla.,

8-31-30, J. O. Nottingham; additional paratypes from the following localities: Mobile, Ala., VI 6, 27, Darlington; DeFuniak Springs, Fla., June 28, 31, P. N. Musgrave; Whiskey creek, Miss., Leaf III 4, 1932, H. Dietrich; Lucedale, Miss., June 22-23, Cedar creek, P. N. Musgrave; Lucedale, Miss., 7-5-31, H. Dietrich; Clara, Miss., Wayne county, June 26, 31.

Remarks and comparative notes. The uniform lighter palpi and darker antennae, comparatively narrower pronotum and less elevated third elytral interval will easily distinguish this species from *S. musgravei* n. sp., to which it is related.

Location of types. Holotype and paratypes in the collection of Dr. Paul N. Musgrave. Allotype and paratypes in the Francis Huntington Snow entomological collection, University of Kansas. Additional paratypes in the Harvard College collection.

Stenelmis quadrimaculata Horn

(Pl. LXXXI, fig. 2)

1870. *Stenelmis quadrimaculatus* Horn, Trans. Am. Ent. Soc. III, p. 40.
1933. *Stenelmis blatchleyi* Musgrave, Proc. Ent. Soc. Wash., Vol. 35, No. 4, p. 57.
1910. 11 *Stenelmis sulcatus* Blatchley, Col. of Ind. p. 681.

Size. Length, 2.7-3.2 mm.; width, 1.1-1.25 mm.

Form and color. Body elongate, convex, nearly parallel. Each elytron usually distinctly bimaculate and never with the vitta entire. Humeral spot on inside of sixth interval.

Head. Granulations between eye and band very fine, rounded, and separated by several times their own diameters. Antennae brownish, nearly piceous in some examples, but always lighter at base. The palpi deep brown to piceous. Antennae as long as pronotum.

Pronotum. Length, .86-1 mm.; width, .77-.87 mm. Inside of sulcus from near its base and occasionally a small area on either side, fuscous. Remainder of pronotum dull yellowish-grey. Sides nearly parallel in basal half, then gradually rounded and subparallel to apex. Slightly wider across rounded sides of pronotum than at base. Apex distinctly shorter than base. Granules on either side of sulcus at base separated by about twice their own diameters. Median longitudinal sulcus distinct, slightly narrowed posteriorly, and extending from about apical one fourth to base. Oblique impression on either side of sulcus distinct and clearly separating lateral tubercles. Basal tubercle rounded.

Elytra. Length, 2-2.35 mm.; width, 1.1-1.25 mm. Each elytron distinctly bimaculate, with the vitta never entire. Humeral spot on inside of sixth interval and occupying nearly all of the fourth and

fifth intervals. Band separating vittae just slightly shorter than humeral spot. Subapical spot extending a little beyond apex of carina of sixth interval. First elytral stria complete from base to apex. Third interval distinctly though not conspicuously elevated near base. Elytral punctures deep on disk, then becoming smaller toward apex of elytra, but never obsolete on declivity.

Venter. Dull red or brownish to greenish-grey with abdominal segments generally dull brown on posterior half. Apical emargination about same as width of last tarsal segment.

Legs. Hind tibiae, .85-.9 mm.; middle tibiae, .65-.75 mm.; anterior tibiae, .7-.82 mm. Last tarsal segment distinctly longer than preceding four combined. Granules of femora occasionally separated by as much as their own diameters, though generally closely placed. Femora and tibiae of the same color as venter, though the tibiae sometimes faintly lighter. Tarsi reddish-brown.

Notes on types. Cotypes of *S. quadrimaculata* Horn, from Bennington county, Vt., and the type of *S. sulcata* Blatch., from Marshall county, Ind., have been examined. They are apparently the same. Variation of pronotal sculpture within many of our species might account for the present species being known under two names. Since *S. quadrimaculata* has priority by forty years, *S. sulcata* should be dropped from our list. *S. blatchleyi* Musgrave was the new name proposed for *S. sulcata* Blatchley, since the latter name was preoccupied by *S. sulcata* Grouvelle, a species described from Sumatra in 1892 (Not. Leyd. Mus. XIV, p. 188).

Remarks and comparative notes. S. quadrimaculata Horn is very closely related to *S. musgravei* n. sp. It may be distinguished by its larger size, less extensive fuscous areas on pronotum, and by certain features of the genitalia. In both species the median lobe of aedeagus possesses evenly rounded lateral processes. In *S. quadrimaculata* these processes are broader than in *S. musgravei*, being about two thirds the width of the median lobe. The median lobe is more pointed and the extreme bases of the lateral lobes are more evenly rounded. In *S. musgravei*, the tip of median lobe is evenly rounded, and the bases of lateral lobes nearly subangulate externally.

Notes on distribution. In addition to the types from Vermont, material from the following localities has been examined:

UNITED STATES:

Indiana: Marshall county, 6-23-34, M. W. Sanderson.

Michigan: Leelenau county, 8-15-33, H. T. Peters: Livingston county, June-July, H. B. Hungerford, Bass L.; Cheboygan county, July, 1936, M. W. Sanderson, Black Lake.

New York: Buffalo (F. C. Bowditch Coll. at Harvard College); Buffalo (Otto Luggar collection at Univ. of Minn.).
District of Columbia: Washington (H. H. Knight collection).

CANADA:

Canada: "Can." (H. H. Knight collection).
Quebec: Wakefield, 20. VII 1932, W. J. Brown (Canadian national collection); Knowlton's Landing, 10, VII 1927, W. J. Brown (Canadian national collection).

Location of types. Cotypes in the Horn collection at the Philadelphia Academy of Sciences. The type of *S. sulcata* Blatch. is in the collection of Prof. W. S. Blatchley, Indianapolis, Ind.

Stenelmis musgravei n. sp.

(Pl. LXXXI, fig. 3)

Size. Length, 2.4-2.65 mm.; width, .95-1.05 mm.

Form and color. Body elongate, convex, nearly parallel. Elytra black, each elytron usually distinctly bimaculate and at least a median clouding on vitta. Humeral spot usually on the inside of the sixth interval.

Head. Granulations between eye and band separated from two to three times their diameters. Antennae and palpi dusky to piceous, the palpi ordinarily darker. Antennae about equal in length to pronotum.

Pronotum. Length, .77-.8 mm.; width, .67 mm. Entire median sulcus to apex of pronotum, and an elongate triangular area on either side of sulcus to a point about two thirds from base—deep brown to black. Remainder of pronotum dull yellowish-grey. Sides of pronotum a little convergent from rounded sides to base. Narrowed about the middle, then subparallel to apex. Slightly narrower at apex of pronotum than at base. Granules on either side of median sulcus separated by once or twice their own diameters. Median longitudinal sulcus distinct, narrowed posteriorly, and extending from about the apical one fourth or one fifth to near base. Oblique impression on either side of median sulcus moderately deep and separating lateral tubercles. Basal tubercle rounded, a little elongate; the anterior tubercle rounded, not prominent.

Elytra. Length, 1.75-1.85 mm.; width, .95-1.05 mm. Each elytron nearly always distinctly bimaculate, and with the humeral spot usually on the inside of the sixth interval. Maculae occupying nearly all of fourth and fifth intervals according to limitations of spot. Band separating spots variable in size, but never entirely absent, occasionally reduced to a faint cloud. Subapical spot terminating

beyond apex of carina of sixth interval. First stria complete from base to apex. Third interval distinctly elevated at base. Elytral punctures deep on disk, finer posteriorly, never obsolete on declivity.

Venter. Light brown to a greenish-grey, the posterior margin and median longitudinal band on last segment lighter. Apical emargination equal to width of last tarsal segment.

Legs. Hind tibiae, .75 mm.; middle tibiae, .62-.65 mm.; anterior tibiae, .64-.67 mm. Last tarsal segment distinctly longer than preceding four combined. Granules of femora separated by less than their own diameters. Femora and tibiae of the same color as venter. Tarsi dark brown to black, the basal two thirds of last segment often a little lighter.

Notes on types. Holotype male, allotype female, and one paratype, Winchester, Va., 7-21-34, M. W. Sanderson. Additional paratypes from Schellburg, Pa., VIII 16; Wardenville, W. Va., July 19, P. N. Musgrave, Trout Run; Sleepy creek, Route 9, Morgan county, W. Va., July 23, 1933; Offutts Isl, Md., 16-7-16, Loomis and Barber, at light; Hollister, Mo., 7-28-34, M. W. Sanderson; and Batavia, N. Y., Sept., 1915, H. H. Knight.

Remarks and comparative notes. As indicated after the description of *S. quadrimaculata* Horn, this species is closely related, but is readily separated by its smaller size. The genitalia are of the same general type but exhibit the differences indicated under *S. quadrimaculata* Horn. It shows some affinities with *S. antennalis* n. sp., but is easily separated by the color of the palpi, which are always as dark as or darker than the antennae. The palpi are always testaceous or lighter in *S. antennalis* n. sp. In two examples of *S. musgravei* n. sp. the humeral spot covers a part of the umbone. However, this is not usual and is not to be regarded as characteristic of the species. These specimens, in this particular, come close to *S. humerosa* Mots., but are distinguished by the distinctly raised third intervals.

Location of types. Holotype, allotype, and paratypes in the Francis Huntington Snow entomological collection, University of Kansas. Additional paratypes in the collection of Dr. Paul N. Musgrave.

Stenelmis sinuata Lec.

1852. *Stenelmis sinuatus* Lec. Proc. Ac. N. S. Phila. VI, p. 44.

Size. Length, 3.25-3.45 mm.; width, 1.2-1.35 mm.

Form and color. Body elongate, moderately subdepressed, distinctly inflated behind. Elytra shiny brown; each elytron with a faint longitudinal vitta on inside of sixth interval.

Head. Granulations between eye and band small but prominent and separated from two to four times their diameters. Antennae and palpi testaceous. Antennae considerably shorter than pronotum.

Pronotum. Length, 1-1.1 mm.; width, .87-.95 mm. Disk of pronotum light brown, but faintly shining. Pronotum generally widest behind middle, then a little convergent to the hind angles, before which there is frequently a slight sinuation. Sides rather suddenly narrowed before the middle, deeply sinuate, the anterior angles usually strongly divergent. The extreme apical angle truncate, the truncation sometimes obtuse. Pronotum usually as wide at base as behind the middle, but never wider at base. Width across the anterior angles but little less than the width at base. Granules on either side of median sulcus at base separated by about twice their diameters. Median longitudinal sulcus very distinctly narrowed posteriorly from near the apical one fourth to the base. Oblique impression on either side of median sulcus distinct, clearly separating lateral tubercles. Basal tubercle elongate, but not distinctly carinate behind. Anterior tubercle moderately elevated and rounded.

Elytra. Length, 2.35-2.5 mm.; width, 1.2-1.35 mm. Each elytron maculate. The vitta only narrow and occupying but little more than fifth interval. First elytral stria complete from base to apex. Third interval conspicuously and acutely elevated at base. The elevation occupying no more than one fourth of the total length of the interval. Elytral punctures are deep on disc and very conspicuous to the apex.

Venter. Nearly uniformly dark brown in the South Carolina specimen. In all others the color is not distinguishable, due to a fine coat of foreign material. Emargination of last abdominal segment a little less than width of last tarsal segment.

Notes on type. The type is a female and is labeled Tallulah, Ga.

Remarks and comparative notes. No males of this species have been examined, though eleven specimens are before me. Most of the examples are covered with vegetable debris, and in some individuals the vittae are all but invisible. This species perhaps shows its closest relationship to *S. vittipennis* Zimm. and allies, but is readily separated by having the sides of pronotum strongly divergent in apical third. The apical angles of pronotum are not acute, as in most of our species, but subtruncate. It is nearly the size of *S. grossa* n. sp. and *S. douglasensis* n. sp., but differs by its granulate instead of punctate legs, pronotum, and venter.

Notes on distribution. In addition to the type from Tallulah, Ga., the following localities are represented in the material at hand:

GEORGIA: Wrens, July 7, 1931, P. N. Musgrave.
ALABAMA: Mobile, June 25, 1931, P. N. Musgrave.
SOUTH CAROLINA: "S. C." (Harvard College collection).
MISSISSIPPI: Lucedale, June, P. N. Musgrave, in Reedy creek.

Location of type. Type in the LeConte collection at Harvard College.

Stenelmis decorata n. sp.

(Pl. LXXXI, fig. 4)

Size. Length, 2.87-3 mm.; width, 1.1-1.15 mm.

Form and color. Body elongate, usually distinctly wider behind, convex. Each elytron with an entire yellowish vitta which is often clouded medially, though not distinctly bimaculate. Vitta on inside of sixth interval.

Head. Granules between eye and band separated from two to three times their own diameters. Antennae and palpi yellow-testaceous, the antennae a little longer than pronotum.

Pronotum. Length, .88-.95 mm.; width, .75-.8 mm. Color varying from deep brown to light grey, basal one third or more, often lighter. Sides rounded just behind the middle, then almost parallel to base, scarcely sinuate before the hind angles. Narrowed and sinuate before the rounded sides, then parallel to apex. Width of pronotum at apex but little less than width at base. Granules immediately on either side of median sulcus at base separated by twice their diameters. Median longitudinal sulcus deep, extending from near apical one fourth of pronotum to base, often a little narrowed posteriorly. Oblique impression distinct and clearly separating lateral tubercles. Basal tubercle small, slightly elongate though never extending to pronotal base; anterior tubercle rounded, distinct but not prominent.

Elytra. Length, 2.12-2.32 mm.; width, 1.1-1.15 mm. Each elytron with the vitta entire, on the inside of sixth interval, covering the fourth and fifth intervals, and extending a little beyond apex of carina of sixth. First elytral stria complete from base to apex. Third interval elevated on basal declivity though usually not acute. Elytral punctures on disk moderate in depth and size, smaller toward apex, never obsolete on declivity.

Venter. Light brown to grey, posterior borders of abdominal segments ordinarily lighter. Apical emargination equal to width of last tarsal segment.

Legs. Hind tibiae, .9-1.1 mm.; middle tibiae, .75-.85 mm.; anterior tibiae, .8-.9 mm. Last tarsal segment a little longer than four preceding combined. Femora and tibiae uniformly dark brown to grey, the tarsi entirely testaceous.

Notes on types. Holotype male, allotype female, Lawrence, Kan., 8-10-32, M. W. Sanderson, at light. Paratypes collected from June 28-Sept. 24, 1930-1932, Lawrence, Kan., at light. Additional paratypes from Douglas county, Kansas, F. H. Snow; Washington, D. C. (H. H. Knight Coll.); "Ind." (Otto Lugger Coll.); Pike county, Ill., 7-10-34, Lowry and Hack.

Remarks and comparative notes. Comparison of the hind tarsi of *S. decorata* n. sp. with those of *S. vittipennis* Zimm. and *S. märkelii* Mots. shows that those of the present species are relatively longer and more slender. The pronotum is usually a little narrower, and the whole aspect is a more slender one than the other two species. It is also on the average smaller. It is readily distinguished from *S. hungerfordi* n. sp., with which it is associated by genital characters, by its narrower form, and distinctly maculate elytra. It is separated from *S. vittipennis* Zimm. and *S. märkelii* Mots. by the absence of lateral processes on the median lobe of aedeagus.

Location of types. Holotype, allotype, and paratypes in the Francis Huntington Snow entomological collection, University of Kansas. Additional paratypes in the collection of Dr. Paul N. Musgrave.

Stenelmis vittipennis Zimm.

(Pl. LXXXI, figs. 5, 9, 10, 12)

1869. *Stenelmis vittipennis* Zimm. Trans. Am. Ent. Soc. II, p. 259.

Size. Length, 3-3.4 mm.; width, 1.1-1.35 mm.

Form and color. Body elongate, moderately convex, nearly parallel. Color of elytra very dark brown to black. Each elytron with an entire testaceous vitta confined to inside of sixth interval.

Head. Granules between eye and band minute, usually separated by several times their diameters, in some cases nearly absent. Antennae and palpi yellow-testaceous. Antennae equal to or slightly shorter than pronotum.

Pronotum. Length, .87-1.05 mm.; width, .8-.95 mm. Color, dull grey, the sulcus fuscous anteriorly. Basal one third or more of sides subparallel. Margin narrowed anteriorly, sinuate and with sides straight to apical angles. Granules on either side of median sulcus at base minute, separated from two to several times their own diameters. Median longitudinal sulcus usually moderate in depth

with sides a little narrowed posteriorly; extending from apical one fourth nearly to base. Oblique impression on either side of sulcus separating lateral tubercles, the impression usually faint. Basal tubercle but slightly raised above the disk and a little elongate, never carinate; anterior tubercle usually rounded and inconspicuous.

Elytra. Length, 2.25-2.6 mm.; width, 1.1-1.35 mm. Each elytron with vitta entire, on inside of sixth interval, and extending posteriorly to a point usually half way between apex of elytron and carina of sixth interval. Vitta covering fourth and fifth intervals, faintly clouded medially in some specimens. First interval elevated at base, though occasionally but little raised. Elytral punctures moderate on disk; finer toward apex, but never obsolete.

Venter. Very light greyish-blue to darker grey, the abdomen distinctly iridescent. The last segment with apical margin usually lighter and which continues as a narrow band to base. Apical abdominal emargination equal to width of tarsal segment.

Legs. Hind tibiae, .97-1.12 mm.; middle tibiae, .75-.87 mm.; anterior tibiae, .87-.97 mm. Last tarsal segment distinctly longer than four preceding combined. Granules on femora very small, rounded, and separated from about two to four times their diameters. Tibiae and tarsi uniformly colored as venter, though less iridescent.

Notes on type. The type of this species from South Carolina has been examined.

Remarks and comparative notes. The present species is closely related to *S. märkelii* Mots. and *S. decorata* n. sp. It may be separated from these two species by the subangulate lateral processes of the median lobe of aedeagus. It also averages a little larger in size than either of the other two species.

Notes on distribution. In addition to the type, the species has been examined from the following localities:

UNITED STATES:

Kansas: Lawrence (Douglas Co.), June 28-Aug. 25, 1930-1932, M. W. Sanderson and L. S. Henderson; Kiowa county, July 5, 1932, R. H. Beamer; Riley county, July 12-19, J. B. Norton (Kan. State College Coll.); Greenwood county, 8-1-1923, Beamer and Lawson.

New Jersey: Spotwood (H. H. Knight collection).

West Virginia: Fairmont, Aug. 3, P. N. Musgrave, at light.

CANADA:

Quebec: Wakefield, 20-VII 1932, W. J. Brown (Canadian national collection); Knowlton, 29. VII. 1930, L. J. Milne.

Manitoba: Aweme, on various dates as follows: 28-30 VIII, 1917, N. Criddle; 13 VIII, 1932, N. Criddle; 12 IX 1922, P. M. White (all from Canadian national collection).

Location of type. Type in the LeConte collection, Harvard College.

Stenelmis convexula n. sp.

(Pl. LXXXI, fig. 8)

Size. Length, 2.75-3.1 mm.; width, 1.1-1.12 mm.

Form and color. Elytra reddish brown to dull grey. Body elongate, convex, distinctly wider behind. Each elytron with a faint humeral and subapical spot. Humeral spot on inside of sixth interval.

Head. Granulation between eye and band separated by twice their own diameters. Antennae and palpi testaceous. Antennae about equal to length of pronotum.

Pronotum. Length, .87-.9 mm.; width, .75-.85 mm. Disk of pronotum dull brown to grey. Anterior margin and angles faintly rufescent. Pronotum widest behind the middle. Slightly convergent to base and generally sinuate before the hind angles; narrowed before the rounded sides, then sides parallel to apex. Pronotum wider at base than apex. Granulations on either side of median sulcus very fine, separated by about three times their own diameters. Median longitudinal sulcus shallow and generally occupying only the median one third of pronotum. Oblique impression on either side ill-defined and barely separating lateral tubercles. Posterior tubercle rounded, not at all elongate; the anterior tubercle nearly indistinct.

Elytra. Length, 2-2.25 mm.; width, 1.1-1.12 mm. Each elytron usually with very faint humeral and subapical spots. Spots on inside of sixth interval and occupying no more than fifth interval at base, subapical spot a little broader and terminating about the end of carina of sixth interval. First elytral stria complete. Third interval but very slight and indistinctly elevated at base. Elytral punctures moderate on disk, becoming finer toward apex and in some examples nearly obsolete on declivity.

Venter. Dull brown to grey. The abdominal segments a little lighter medially. Last ventral segment with a narrow apical emargination equal to width of last tarsal segment.

Legs. Hind tibiae, .75-.87 mm.; middle tibiae, .62-.7 mm.; anterior tibiae, .65-.75 mm. Last tarsal segment longer than preceding four combined. Granules of femur separated by no more than their own diameters. Femora and tibiae colored above as venter. Femora noticeably lighter below. Apex of femur, base and apex of tibia lighter. Tarsi reddish brown.

Notes on types. Holotype male, allotype female and twenty-five paratypes, DeFuniak Springs, Fla., June 28, 1931, P. N. Musgrave.

Remarks and comparative notes. This species bears some resemblance to *S. fuscata* Blatch. and *S. hungerfordi* n. sp. It differs from the former by the possession of elytral spots, and from this species and *S. hungerfordi,* it differs by its more convex and broader form. The lateral processes of aedeagus are rounded but broader than *S. märkelii* Mots. *S. convexula* n. sp. appears to be a little more convex through the humeri than other species in our fauna.

Location of types. Holotype, allotype, and paratypes in the collection of Dr. Paul N. Musgrave, Fairmont, W. Va. Additional paratypes in the Francis Huntington Snow entomological collection, University of Kansas.

Stenelmis märkelii Mots.

(Pl. LXXXI, figs. 11, 14, 16)

1854. *Stenelmis markelii* Mots. Etudes Entomologiques, p. 12.
1859. *Stenelmis märkelii* Mots. Etudes Entomologiques, p. 50.

Size. Length, 3-3.25 mm.; width, 1.17-1.3 mm.

Form and color. Body elongate, convex, nearly parallel. Color of elytra piceous-brown to black, each elytron with an entire longitudinal testaceous vitta which is confined to inside of sixth interval.

Head. Granules between eye and band separated from one to several times their own diameter. Antennae and palpi light brownish-testaceous. Antennae about equal in length to pronotum.

Pronotum. Length, .9-1 mm.; width, .85-.9 mm. Median sulcus, and from its anterior extremity to apex of pronotum, fuscous. Remainder of pronotum dull grey. Sides rounded behind the middle, then slightly convergent to base. Narrowed anteriorly, with a shallow sinuation before anterior angles. Granules on either side of sulcus at base, and entire upper surface, separated by about twice their diameters. Median longitudinal sulcus moderate in depth, narrowed posteriorly and extending from apical one third to near the base. Oblique impression on either side of median sulcus inconspicuous and shallowly separating lateral tubercles; the tubercles rounded and barely evident.

Elytra. Length, 2.25-2.4 mm.; width, 1.17-1.3 mm. Each elytron with the vitta entire, on inside of sixth interval, and extending posteriorly to a little beyond apex of carina of sixth interval. Vitta covering fourth and fifth intervals except at middle, where vitta is slightly narrowed. First elytral stria complete from base to apex. Third interval in type just perceptibly elevated near base. Elytral

punctures moderate in size and depth on disk, never obsolete on apical declivity.

Venter. Light grey to brown with the abdominal segments nearly uniform in coloration. Apical abdominal emargination equal to width of last tarsal segment.

Legs. Hind tibiae, .9-1.12 mm.; middle tibiae, .8-.9 mm; anterior tibiae, .85-1 mm. Last tarsal segment distinctly longer than preceding four segments combined. Granules on femora of most examples generally separated from once to twice their diameters. Femora and tibiae entirely grey, the tarsi reddish-brown.

Notes on types. The type series of four males bearing the label: "Stenelmis Märkelii Motsch. Teness." has been examined. One of these specimens has been dissected and designated as *lectotype*. The granules on the femora of three of the specimens are a little more closely placed than on the specimen selected as the type.

Remarks and comparative notes. This species is very closely related to *S. vittipennis* Zimm. and is only satisfactorily separated from that species by the character of the aedeagus. The processes of the median lobe of *S. märkelii* Mots. are evenly rounded, and not subangulate anteriorly, as in *S. vittipennis* Zimm. There is also a close resemblance to *S. decorata* n. sp., but the latter has the median lobe without processes.

Notes on distribution. In addition to the type series from Tennessee, the species has been examined from:

ARKANSAS: Berryville, 7-4-34, R. H. Beamer, at light.
MISSOURI: Hollister, 7-28-34, M. W. Sanderson, Long Creek.
MASSACHUSETTS: Chicopee (W. Knaus collection).
PENNSYLVANIA: "Penn." (Otto Lugger collection); "Pa."

Location of types. In the Zoölogical Museum of Moscow, U. S. S. R.

ADDENDA

The following two species of Stenelmis are the only known Western Hemisphere species not found in the United States. Although neither is closely related to the others, their original descriptions are added here for the sake of completeness.

Stenelmis geayi Grouv.

1908. *Stenelmis Geayi* Grouv. Bull. du Mus. d'Hist. Nat., 14, pp. 181-182.

ORIGINAL DESCRIPTION

"Oblongo-elongata, subparallela, convexa, opaca, nigrofumosa, maculis griseis in capite prothoraceque, avellaneis in elytris variegatus. Antennae tenues, rufo-testacese, articulis omnibus multo

longioribus quam latis. Caput transverso-oblongum, margine antico ante bases antennarum inflexo; oculis magnis, satis admotis, labro rufo-testaceo. Prothorax antice valde angustus vix longior quam ad basin latus, in longitudinem subsulacatus; haud dense punctulatus, punctis ad latera majoribus; margine antico valde producto, medio et utrinque sinuato; lateribus arcuatis, ad basin sinuatis; basi trisinuata; angulie anticis late obtusis, subhebetatis, posticis acutis, extus productis. Scutellum suborbiculare. Elytra prothorace latiora, ad apiceum subseparatim acuminata, magis duplo longiora quam simul lata, punctato-striata; intervallis striarum punctis latioribus; humeris calosis, subdentatis; disco ad apiceum sat abrupte declivo, intervallo 6° ad initium partis inclinatae per tuberculium acuminatum armato. Tarsi rufo-testacei. Long., 5-5 millim. 5.

"Oblong, allongé, subparallèle, convexe, moir, grisâtre, légèrement violacé, varié de taches grises sur la tête et le prothorax; grises, légèrement rosées sur les élytres; taches mal limitées, formant principalement sur le prothorax une band antérieure médiane et deux bandes latérales, basilaires, et sur les élytres une série de bandes linéaires couvrant les stries, se soudant parfois et groupées à la base sur les 2^e, 3^e, 4^e et 5^e stries, sur les côtés sur les 4^e, 5^e, et 6^e, sur le disque vers la partie déclive, sur les 2^e, et 3^e; strie sutturale presque entièrement couverte par une tache lineaire, souvent interrompue sur les intervalles de points. Antennes roux-testacé grêles; tous les articles beaucoup plus dongs que larges. Tête en ovale transversal, infléchie un peu en avant de la naissance des antennes, cellesci relativement rapprochées à la base; yeus gros; labre roux testacé; dernier article des palpes maxillaires allongé, oblong. Prothorax fortement rétréci en avant, un peu plus long que large à la base, longitudinalement subsillonné dans le milieu, couvert d'une punctuation profonds, peu serrée, fine sur le disque, plus forte sur les côtés; bord antérieur fortement saillant en avant, arrondi, sinué dans le milieu et de chaque côté; bords laterau arrondis, sinues avant la base; base trisinuée; angles antérieurs largement obtus, postérieurs aigus, réfléchis en dehors; sur le disque de chaque côté du sillon longitudinal, vers le premier tiers à partir de la base, une petite élévation conique. Ecusson suborbiculaire. Elytres plus larges que le prothorax, subacuminée séparément au sommet, environ deux fois et un tiers aussi longs que larges ensemble, ponctués-striés; intervalles des stries plus larges que les points, ceux-ci plus forts à la base qu'ar sommet; partie apicale des elytres assez fortement et brusquement déclive; calus huméraux

allongés, subdentés; 8° intervalle externe légèrement caréne, terminé vers la partie déclive de l'elytre par un tubercule acuminé. Tarses rouxtestace. Métasternum fortement creusé pour recevoir la saillie du prosternum; saillie du premier segment ab dominal très largement obtuse.

"Il exemplaires.—Guyane; rivière Lunier (F. Geay). Collection du Muséum de Paris.

"Espèce remarquable par les taches d'un aspect limoneux, mal définies qui décorent son prothorax et ses élytres."

NOTES

Two specimens of this species from the type series have been studied. It is not closely related to any species found within the United States although it possesses certain characters peculiar to the *Sinuata-humerosa* group. The last tarsal segment is very much longer than the four preceding combined, and the claw is proportionately larger. The punctures of the pronotum are very fine, a character which is found only in *S. grossa* Sand. and *S. douglasensis* Sand, both of which are in the *Sinuata-humerosa* group. Otherwise *S. geayi* Grouv. departs from all other species in the Western Hemisphere in many characters. The entire body is peculiarly patterned with dark and light grey which extends on to the legs; the antennae are very slender and are longer than the pronotum by the last three segments. The antennae and palpi are brownish-testaceous. The pronotal sulcus is shallow and extends nearly the full length of pronotum. The margin of pronotum at the anterior end of sulcus is distinctly emarginate. On either side of sulcus, near basal third, is a rounded prominence, and opposite this, near lateral margin, is another slightly smaller prominence. The third elytral interval is elevated a little behind extreme base and with the intervals on either side slightly prominent. The sixth interval is elevated and prominent at extreme base. In the apical fourth of the seventh elytral interval, there is a conspicuous dentiform process. The apices of the elytra are separate.

For the present I must regard this as congeneric with the European *Stenelmis canaliculata* (Gyll.) although its facies and robustness are quite unlike other species known to me. In general appearance it recalls certain Curculionids. The absence of patches of tomentum on the inside of the tibiae would seem to exclude it from the closely related Cylloepus.

Types are located in the Paris Museum and in the Francis Huntington Snow entomological collection, University of Kansas.

Stenelmis nevermanni Hinton

1936. *Stenelmis nevermanni* Hntn. Trans. Royal Ent. Soc. London, 85, pp. 424-426.

ORIGINAL DESCRIPTION

"Male. Elongate, subparallel, moderately convex. Surface throughout microscopically alutaceous; above with the scutellum glabrous, elsewhere sparsely clothed with very fine, moderately long recumbent, pale-testaceous hair; elytra near apex with a few fine, erect hairs which are often about as long as the combined length of the two basal antennal segments; upper surface in many specimens brownish-cinereous, due to a fine deposit of earthy material; beneath clothed throughout with minute, dense tomentum and also clothed as above. Derm pale brownish-piceous, feebly shining. *Head* with the clypeal suture nearly straight; anterior margin of clypeus truncate, with the angle on each side obtusely rounded; antennae long and slender, extending slightly beyond basal prothoracic angles. Surface very finely granulate, with the granules apparently seldom separated by more than five times their diameters. *Prothorax* longer than broad (30:26-5), broadest across basal one third; base broader than apex (25:19). Apical margin feebly arcuate, feebly sinuate on each side behind eye; apical angles inconspicuous, when viewed laterally feebly produced forwards, obtusely rounded; sides moderately converging towards apex, feebly, broadly sinuate in apical one half and feebly, more narrowly sinuate before basal angles, lateral margins indistinct, nearly obsolete, finely crenate due to fine lateral granules; basal margin moderately strongly trisinuate, broadly so on each side and narrowly so in front of scutellum. Pronotum unevenly convex, without definite sublateral carinae; median longitudinal impression feeble, extending from basal one fourth to apical one third, deepest at apical one third. Surface slightly coarsely, densely often confluently rugosely punctate; with fine granules which are especially anteriorly and at sides separated mostly by two to seven or more times their diameters. *Elytra* more than twice as long as prothorax (68:30), broader across apical one third than at humeri (39:35). Intervals nearly flat, alternate discal intervals (1, 3, 5, and 7) slightly paler in colour than others; strial punctures moderately coarse, subquadrate to round and on disk separated mostly by one to five times their diameters. Apices moderately broadly but somewhat shortly produced, conjointly truncate. Scutellum elongate, subovate, broadly rounded basally, acuminate apically, length to breadth ratio is 6.5:3.8, flat, glabrous, shining. *Surface beneath* finely granulate. Prosternal process as figured.

Metasternum depressed posteriorly; with the median longitudinal line extending only to anterior one third. Middle of first ventral abdominal segment not noticeably depressed, granulate similarly to metasternum, sides and other ventral segments much more finely granulate than metasternum. Claws slender, not toothed. Length, 3.6 mm.; breadth, 1 mm.

"Female externally similar to male.

"*Type:* a male in my collection Costa Rica: Reventazon, 1. xi. 1934, at light (F. Nevermann).

"*Paratypes:* Twelve collected by the same collector at the same locality during the following different times:—. xi. 1931, —, ii. 1932, —. vii. and —. xi. 1934.

"Certain specimens appear to have a feebly developed fringe of tomentum on the inner apices of the tibiae, but in all other respects the species is a true *Stenelmis*. It is the only species of this cosmopolitan genus so far recorded from the Mexican or Central American region. It is close to none of the North American (U. S. A.) species known to me."

NOTES

Two specimens of this species from the type series have been studied. Again this species is not closely related to those within the United States, although it possesses certain characters which would more closely associate it with the *Crenata* group. The last tarsal segment is a little smaller than the preceding four combined, and the claw is small and slender. The antenna is longer than the pronotum by the length of the last three segments. The third elytral interval is but slightly elevated behind the extreme base, and the sixth interval is not at all cariniform, as in the United States species. The pronotum and venter are, in part, granulate, but the legs are minutely punctulate. The extreme apices of the elytra meet at the suture, and are squarely truncate.

This species, although agreeing with *S. geayi* Grouv. by its longer antennae, is perhaps more closely related to the United States species. It is smaller than *S. geayi,* slender, and is not variegated with color.

The type and paratypes are located in the collection of Mr. Howard E. Hinton, Berkeley, Cal. A paratype has been deposited in the Francis Huntington Snow entomological collection, University of Kansas.

The two references below are to species which originally were included in Stenelmis:

Cylloepus puncticollis (Hntn.)

1934. *Stenelmis puncticollis* Hntn. Revista de Entomologia, IV, pp. 198-199.

I have not examined this species, but in a letter from its author, it has been referred to Cylloepus. Cleaning and study of the anterior tibiae have shown the presence of tufts of tomentum on the inner sides.

Microcylloepus pusillus (Lec.)

1852. *Stenelmis pusillus* Lec. Proc. Ac. N. S. Phila. VI, p. 44.
1869. *Limnius pusillus* (Lec.) Zimmerman, Trans. Am. Ent. Soc., II, p. 259.
1870. *Elmis pusillus* (Lec.) Horn, Trans. Am. Ent. Soc. III, pp. 29-42.
1935. *Microcylloepus pusillus* (Lec.) Hinton, Stylops, Vol. 4, pt. 8, pp. 178-179.

The new genus Microcylloepus was erected by Hinton for this and a number of related species.

Stenelmis canaliculata (Gyll.)

I have examined the type of *Stenelmis elongata* Mots.[*] which is labeled: "Stenelmis elongatus Motsch. Am. bor.?" Careful comparison of the type with an authentically determined specimen of the European *Stenelmis canaliculata* (Gyll.) convinces me that the two are the same. *S. elongata* Mots. thereby becomes a synonym of *S. canaliculata* (Gyll.) and should be dropped from our lists.

LIST OF AMERICAN SPECIES OF STENELMIS

[*] Etud. Entom. VIII, 1859, p. 51.

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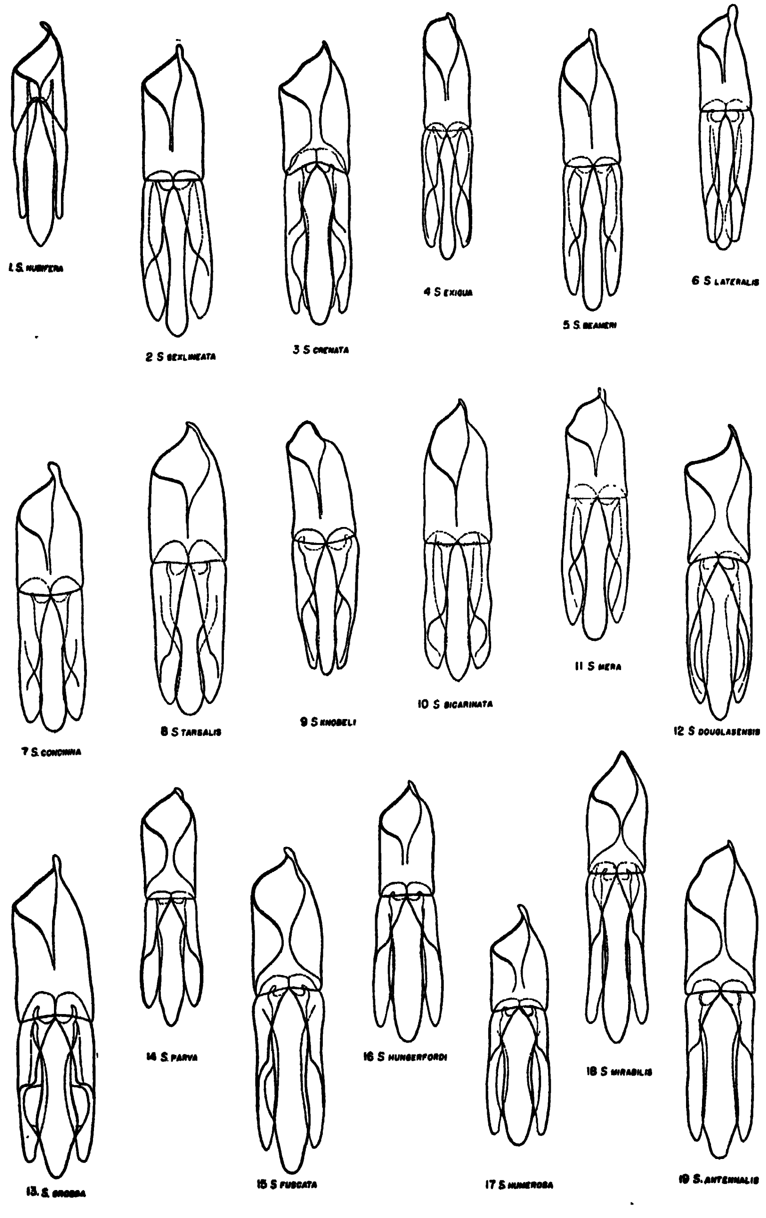
PLATE LXXX

FIGS. 1 to 19. Male genitalia of Stenelmis.

PLATE LXXX



1 S. NUBIFERA
2 S. SEXLINEATA
3 S. CRENATA
4 S. EXIGUA
5 S. BEAMERI
6 S. LATERALIS
7 S. CONCINNA
8 S. TARSALIS
9 S. KNOBELI
10 S. BICARINATA
11 S. MERA
12 S. DOUGLASENSIS
13. S. GROSSA
14 S. PARVA
15 S. FUSCATA
16 S. HUNGERFORDI
17 S. HUMEROSA
18 S. MIRABILIS
19 S. ANTENNALIS

PLATE LXXXI

FIG. 1. *Stenelmis lateralis* Sand. n. sp.

FIGS. 2 to 5. Male genitalia of Stenelmis species.

FIGS. 6 and 7. Antennae of Stenelmis species.

FIG. 8. Male genitalia.

FIG. 9. Middle tibia of female.

FIG. 10. Middle tibia of male.

FIG. 11. Male genitalia.

FIGS. 12 and 13. Figures showing lower margin of last tarsal segment with and without tooth-like projection.

FIG. 14. Tarsus of a species of *Sinuata-humerosa* group. The terminal segment is equal to the four preceding combined; the claws are more robust.

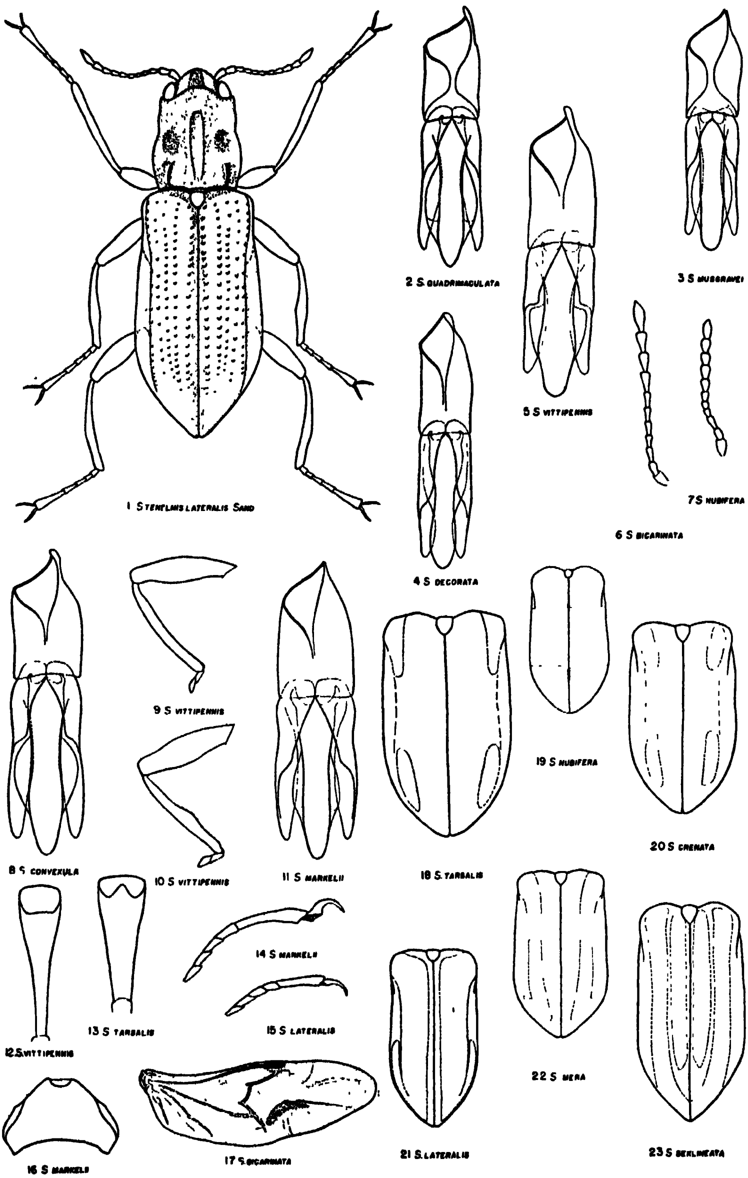
FIG. 15. Tarsus of a species of *Crenata* group. The terminal segment is shorter than the four preceding combined; the claws are more slender.

FIG. 16. Last visible ventral abdominal segment showing apical emargination.

FIG. 17. Figure showing well-developed hind wing.

FIGS. 18 to 23. Outlines of types of elytral patterns in Stenelmis species

PLATE LXXXI


1 Stenelmis lateralis Sand
2 S. quadrimaculata
3 S musgravei
4 S decorata
5 S vittipennis
6 S bicarinata
7 S nubifera
8 S convexula
9 S vittipennis
10 S vittipennis
11 S markelii
12 S vittipennis
13 S tarsalis
14 S markelii
15 S lateralis
16 S markelii
17 S bicarinata
18 S tarsalis
19 S nubifera
20 S crenata
21 S lateralis
22 S mera
23 S sexlineata